APPENDIX S-I

LAKE ERIE AND GRAND RIVER BASELINE HUMAN HEALTH RISK ASSESSMENT FOR SITE-WIDE ISSUES

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JUNE 2003

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ABS	Absorption Fraction
AF	Adherence Factor
ATSDR	Agency for Toxic Substances and Disease Research
B(a)P	Benzo(a)pyrene
bgs	Below ground surface
CADAD	Chronic Average Daily Absorbed Dose
CADD	Chronic Average Daily Dose
COI	Chemical of Interest
DSCC	Diamond Shamrock Chemical Company
EPC	Exposure Point Concentration
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LADAD	Lifetime Average Daily Absorbed Dose
LADD	Lifetime Average Daily Dose
LMS	Linearized Multistage Model
LOAEL	Lowest-Observed-Adverse-Effect-Level
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No-Observed-Adverse-Effect-Level
OAF	Oral Absorption Factor
OEPA	Ohio Environmental Protection Agency
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCOI	Preliminary Chemical of Interest
PRG	Preliminary Remediation Goal
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference Dose

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RI	Remedial Investigation
RME	Reasonable Maximum Exposure
SA	Surface Area
SF	Slope Factor
SVOC	Semivolatile Organic Compound
TDS	Total Dissolved Solids
TIC	Tentatively Identified Compound
TPH	Total Petroleum Hydrocarbon
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
VAP	Voluntary Action Plan
VOC	Volatile Organic Compound
WOE	Weight of Evidence

EXECUTIVE SUMMARY

This report presents the Lake Erie and Grand River Baseline Human Health Risk Assessment for Site-Wide Issues (Lake Erie and Grand River Baseline HRA) at the Diamond Shamrock Painesville Works Site (Site), namely the human exposure pathways and risks associated with potential impacts of soils and groundwater at the Site to Lake Erie and the Grand River. Property-specific risk assessments will be submitted separately to address potential soil exposures and groundwater volatilization exposures at defined Operable Units (OUs) to support the feasibility studies based on reasonably anticipated land use at each OU. When taken together, this risk assessment for site-wide issues combined with the Operable Unit risk assessments will address all potential exposures and risks for the entire Site. This Lake Erie and Grand River Baseline HRA was prepared in a manner consistent with the *Work Plan for the Human Health and Ecological Risk Assessment for the Painesville Works Site* (SECOR, 1997) as well as other applicable Ohio EPA and United States Environmental Protection Agency (USEPA) guidance and criteria for risk assessment (Ohio EPA, 1996; USEPA, 1989a; USEPA, 1991a; USEPA 1991b; USEPA , 1992b; USEPA , 1992c; USEPA , 1996a; USEPA ,1996b; USEPA ,1997a).

The objectives of this Lake Erie and Grand River Baseline HRA were as follows: (1) to determine the chemicals of interest (COIs); (2) to evaluate the complete exposure pathways at the Site with respect to Lake Erie and the Grand River; (3) to estimate the potential exposures to identified receptor populations via the complete exposure pathways; and (4) to estimate potential cancer risks and non-cancer hazards associated with the COIs and the identified receptor populations. The Lake Erie and Grand River Baseline HRA addressed current and reasonably anticipated future conditions at the Site, assuming no further remediation.

With respect to site-wide issues, complete and potentially significant pathways for human exposure to COIs associated with the Site are:

- Potential releases from former and current industrial process areas and the former coke plant area, north of Fairport Nursery Road, through surface soil runoff and/or groundwater migration into Lake Erie, with subsequent exposures to chemicals in surface water, sediment and fish by persons using the Lake for recreational activities. Potential exposure pathways include dermal contact and incidental ingestion of surface water and sediment, and ingestion of fish caught near the shore adjacent to the Site.

- Potential releases from former Solvay process residue settling basins, the former hydroretention basin, the chromium ore processing residue landfill and the Painesville Township Landfill through surface soil runoff and/or groundwater migration and/or leachate into the Grand River, with subsequent exposures to chemicals in surface water, sediment and fish by persons using the River for recreational activities. Potential exposure pathways include dermal contact and incidental ingestion of surface water and sediment, and ingestion of fish caught in the River adjacent to the Site.

The evaluation of chemical constituents in this Lake Erie and Grand River Baseline HRA was based upon data collected as part of the Phase I Remedial Investigation and the Phase II Remedial Investigation, and other appropriate data as described in detail in Section 2 of this Lake Erie and Grand River Baseline HRA. A screening procedure was established to identify those COIs which required further quantitative evaluation in the risk assessment. The screening process eliminated chemicals that were: (1) tentatively identified compounds; (2) essential human nutrients; (3) detected in fewer than 5% of samples; (4) laboratory contaminants that were also detected in laboratory blanks; (5) inorganic compounds measured at concentrations that are consistent with background concentrations; and (6) chemicals whose concentrations were below health-based screening levels.

The risk assessment determined that the following COIs have complete and potentially significant human health exposure pathways for the Grand River and Lake Erie:

- **Grand River**
    - *Groundwater to Surface Water*
        - Antimony
        - Chromium VI
        - Mercury
        - Vinyl Chloride
    - *Sediment*
        - Aluminum
        - Antimony
        - Arsenic
        - Cyanide
        - Manganese
        - Thallium
- **Lake Erie**
    - *Groundwater to Surface Water*
        - Antimony
        - Carbon tetrachloride

  - Chloroform
  - Methylene Chloride

- *Sediment*
  - Arsenic
  - Benzo(a)anthracene
  - Benzo(a)pyrene
  - Benzo(b)fluoranthene
  - Dibenz(a,h)anthracene
  - Indeno[1,2,3-cd]pyrene
  - Manganese
  - Thallium

In addition to the Grand River COIs listed above, trivalent chromium was quantitatively evaluated for Grand River fish ingestion exposures due to Ohio EPA's concerns about chromium migration from Study Area 6 to the Grand River. Total chromium and hexavalent chromium were also evaluated for Grand River surface water exposures (dermal contact and incidental ingestion), even though the maximum detected concentration in surface water for neither form of chromium exceeded its human health non-drinking water quality criterion. These additional evaluations were performed since the human-health based screening criteria (human health water quality standards for non-drinking water) are based on eating fish and do not quantify direct contact exposures.

Human exposures and risks were quantitatively estimated for the COIs and those additional chemicals listed above. Human exposures at the Grand River were determined to include recreators (adults and children engaged in recreational activities), including:

> exposure to river water and sediment, and fish ingestion, by adults and children who fish from and wade in the Grand River.

Human exposures at Lake Erie were determined to include recreators, including:

> exposure to lake water and sediment, and fish ingestion, by adults and children who fish from and wade in Lake Erie.

This Lake Erie and Grand River Baseline HRA evaluated the potential reasonable maximum exposures to recreational users of the river and lake using a combination of conservative default exposure assumptions specified in regulatory guidance and protective site-specific assumptions for the two receptor populations of interest (*i.e.*, the Adult Recreator and the Child Recreator). From these upper-bound estimates of exposure, potential non-cancer hazards and cancer risks posed by the COIs were estimated. The excess lifetime cancer risks estimated for the two receptor populations of interest did not exceed the acceptable excess lifetime cancer risk goal of 1×10^{-5}. Similarly, the total hazard indices for both receptor populations of interest were below the acceptable goal of unity (1).

Potential releases of COIs from groundwater discharges to the Grand River and Lake Erie were evaluated using a groundwater fate and transport model (BIOSCREEN) (see Section 3.2.1). The predicted surface water concentrations at the point of discharge to surface water were compared to surface water quality standards for the protection of human health (non-drinking). This evaluation was performed to determine the potential for releases from the Site in groundwater to impact persons eating fish from the river and lake. All chemicals detected in groundwater at concentrations above their respective Outside Mixing Zone Average (OMZA) water quality standards were evaluated for their potential to migrate and discharge into Lake Erie and/or the Grand River, with assistance from Ohio EPA. The BIOSCREEN model was used to predict concentrations of chemicals of interest in groundwater at the point of discharge to surface water, assuming the maximum detected concentrations in each well migrate to the Lake and/or River by the shortest groundwater flow path. Model predicted concentrations at the points of discharge were compared to OMZA surface water quality standards for the protection of human health (non-drinking). Model predicted concentrations at the point of discharge to Lake Erie exceed the OMZA surface water quality standards for four chemicals (antimony, carbon tetrachloride, chloroform, and methylene chloride). Model predicted concentrations at the point of discharge to the Grand River exceed the OMZA surface water quality standards for four chemicals (antimony, chromium VI, mercury, and vinyl chloride).

COIs in Grand River surface water and sediment were included in a quantitative risk assessment for dermal and incidental ingestion exposures by recreators (see Sections 3.4.3, 3.4.4, 3.4.5, and 3.4.6). These estimated risks were added to estimated risks from the ingestion of chromium in the tissues of fish caught from the river adjacent to the Site, even though detected concentrations of chromium in river water samples did not exceed the OMZA surface water quality criterion for the protection of humans for fish ingestion. The non-carcinogenic hazard index (HI) values presented in Table 17 show that the total HI for the Grand River Adult Recreator receptor population is 0.1 and the total HI for the Grand River Child Recreator receptor population is 0.5. The total estimated lifetime excess cancer risk posed to the Grand River Adult Recreator receptor population is 4.3×10^{-6} and the total estimated lifetime excess cancer risk for the Grand River Child Recreator is 7.5 x 10^{-6}. Thus, acceptable non-cancer hazards and acceptable excess lifetime cancer risks have been demonstrated for both Grand River receptor populations.

The Lake Erie sediment data indicates that eight chemicals detected in the four Lake Erie sediment samples exceeded the USEPA Region IX residential soil PRGs. The exposure assumptions used to develop the PRGs are associated with human activities in residential soil, and these assumptions differ from those that may be associated with activities in sediment. Given the physical habitat constraints (steep cliff shoreline, rocks, debris, and hard clay bottom in some areas) and the depth at which sediment was collected, there is a low potential for the recreational user to come in contact with the sediment; a qualitative evaluation was therefore conducted. The metals are within the range of background concentrations in Lake Erie sediment (published by Painter et al., 1998), and Grand River sediment collected by Ohio EPA upstream of the Site. The PAHs may originate from several sources, including runoff from Fairport Harbor, and releases associated with the marina in addition to Study Area 2. If elevated PAH levels are detected in the event of further investigations in Study Area 2 during the feasibility study, additional evaluation will be conducted, as appropriate.

Based upon the results of this Lake Erie and Grand River Baseline HRA, it is concluded that the following chemicals detected in groundwater at the Site should be evaluated in the Feasibility Study (FS) because their model predicted concentrations exceed OMZA surface water quality standards for the protection of human health (non-drinking) at the point of discharge to either Lake Erie or the Grand River:

- **Grand River**
  - Antimony
  - Hexavalent chromium
  - Mercury
  - Vinyl chloride
- **Lake Erie**
  - Antimony
  - Carbon Tetrachloride
  - Chloroform
  - Methylene Chloride

1.0 INTRODUCTION

This Partial Baseline Human Health Risk Assessment for Site-Wide Issues (Lake Erie and Grand River Baseline HRA) was prepared on behalf of the Painesville Potentially Responsible Party Group (the PRP Group) for the Diamond Shamrock Painesville Works site (Site) by Hull & Associates, Inc. (Hull). The Lake Erie and Grand River Baseline HRA addresses the human exposure pathways and risks associated with potential impacts of soils and groundwater at the Site to Lake Erie and the Grand River. Property-specific risk assessments will be submitted separately to address potential soil exposures and groundwater volatilization exposures at defined Operable Units (OUs) as part of feasibility studies based on planned property development and use at each OU. When taken together, this risk assessment for site-wide issues combined with the Operable Unit risk assessments will address all potential exposures and risks for the entire Site. If additional information regarding soil impacts or potential soil impacts to either Lake Erie or the Grand River are found in the "Operable Units risk assessments", the Lake Erie and Grand River Baseline HRA will be updated, as necessary.

The Lake Erie and Grand River Baseline HRA was prepared in a manner consistent with the *Work Plan for the Human Health and Ecological Risk Assessment for the Painesville Works Site* as well as other applicable Ohio Environmental Protection Agency (Ohio EPA) and United States Environmental Protection Agency (USEPA) guidance and criteria for risk assessment (Ohio EPA, 2002; Ohio EPA, 1996; USEPA, 1989a; USEPA, 1991a; USEPA 1991b; USEPA , 1992b; USEPA , 1992c; USEPA , 1996a; USEPA ,1996b; USEPA ,1997a). The Lake Erie and Grand River Baseline HRA incorporates all revisions requested by Ohio EPA when reviewing previous Diamond Shamrock Painesville Works human health risk assessment reports.

This Lake Erie and Grand River Baseline HRA evaluates impacts from the Site to the surface waters and sediments in Lake Erie and the Grand River, and to edible fish caught from the Grand River, with respect to potential human health exposures and risks. The surface water and sediment impacts are also evaluated with respect to ecological receptor populations in a companion volume, the Lake Erie and Grand River *Baseline Ecological Risk Assessment for Site-Wide Issues* (Lake Erie and Grand River Baseline ERA). Thus, many aspects of the site conceptual model are common to both the Lake Erie and Grand River Baseline HRA and the Lake Erie and Grand River Baseline ERA, and some information is cross-referenced between the two documents.

This Lake Erie and Grand River Baseline HRA incorporates the site data collected during the 1997 Remedial Investigation (Phase I RI) as well as the Remedial Investigation conducted from 1999 through 2001 (Phase II RI) (SECOR, 1999; SECOR, 2002). The objectives of this Lake Erie and Grand River Baseline HRA are to use the results of the Phase I RI and Phase II RI, in conjunction with any relevant historical data to:

1. evaluate the impacts of chemicals of interest (COIs) upon Lake Erie and the Grand River;
2. provide an analysis of the baseline health risks, *i.e.*, those excess lifetime cancer risks and non-cancer hazards posed to certain human receptor populations that might exist if no further remediation were applied at the site;
3. provide a point of departure for determining which areas of the site, if any, may require additional characterization;
4. provide a basis for determining the concentrations of COIs that can remain on-site without adversely impacting human health; and
5. provide a basis for comparing various remedial alternatives, if warranted, based on impacts to human health.

1.1 Report Organization

The organization of this risk assessment follows guidelines published by the National Research Council (NRC) in 1983 and suggested by the USEPA (1989a). The Academy recommends that risk assessments should contain some or all of the following four steps: hazard identification, exposure assessment, dose-response assessment (toxicity assessment), and risk characterization. Each of these steps is addressed in separate sections of this Lake Erie and Grand River Baseline HRA.

The remainder of the report is organized as follows:

2.0 ***Hazard Identification*** **–** This section summarizes the site history, identifies the potential source and exposure areas, summarizes chemical data for the Site, and describes and implements the methodology for identifying the chemicals of interest.

3.0 ***Exposure Assessment*** – This section presents the Site Conceptual Model and identifies the complete exposure pathways and potentially exposed populations. Fate and transport modeling to evaluate exposure potential is presented. Exposure factor assumptions, such as contact rate and duration, are presented. The Chronic Average Daily Dose (CADD) or Chronic Average Daily Absorbed Dose (CADAD) for non-carcinogens, and the Lifetime Average Daily Dose (LADD) or Lifetime Average Daily Absorbed Dose (LADAD) for carcinogens are calculated and presented in this section.

4.0 ***Toxicity Assessment*** **–** This section characterizes the relationship between the magnitude of exposure to the chemicals of interest, and the probability of the occurrence of an adverse health effect. This section also identifies the USEPA verified toxicity criteria to be used in the risk characterization.

5.0 ***Risk Characterization*** **–** This section provides a description of the nature and magnitude of human health risks associated with exposure to the COIs and a comparison to risks considered to be acceptable by the Ohio EPA and USEPA.

6.0 ***Conclusions*** - This section lists the key findings presented in the report.

7.0 ***References*** **–** This section provides the citations to the peer-reviewed literature and regulatory guidance used in the Lake Erie and Grand River Baseline HRA.

TABLE 1
CHEMICALS DETECTED IN GRAND RIVER SURFACE SEDIMENT AND SELECTION OF PCOIs[a]

Parameter	Number of Detects	Total Number of Samples	Detection Frequency	Detection Frequency Less than or Equal to 5%?	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)
ALUMINUM	18	18	100.0%	NO	3020	17600
ANTIMONY	1	8	12.5%	NO	4	4
ARSENIC	12	18	66.7%	NO	7.7	52.3
BARIUM	18	18	100.0%	NO	10.4	440
BENZENE	2	11	18.2%	NO	0.075	0.19
BENZO(A)ANTHRACENE	1	18	5.6%	NO	0.36	0.36
BERYLLIUM	18	18	100.0%	NO	0.28	3
BIS(2-ETHYLHEXYL)PHTHALATE	3	18	16.7%	NO	0.3	0.7
BUTYLBENZYLPHTHALATE	1	18	5.6%	NO	0.41	0.41
CADMIUM	8	8	100.0%	NO	1.3	1.9
CARBON DISULFIDE	2	11	18.2%	NO	0.002	0.002
CARBON TETRACHLORIDE	2	11	18.2%	NO	0.003	0.003
CHLOROBENZENE	1	11	9.1%	NO	0.092	0.092
CHROMIUM	16	18	88.9%	NO	4.9	111
CHRYSENE	1	18	5.6%	NO	0.38	0.38
COBALT	18	18	100.0%	NO	3.3	14.6
COPPER	18	18	100.0%	NO	6.6	33
CYANIDE	5	5	100.0%	NO	0.76	2.7
4,4'-DDD	1	18	5.6%	NO	0.0036	0.0036
1,1-DICHLOROETHANE	1	22	4.5%	YES	0.001	0.001
1,2-DICHLOROETHANE	2	11	18.2%	NO	0.004	0.01
1,2-DICHLOROETHENE(TOTAL)	3	11	27.3%	NO	0.002	0.033
ETHYLBENZENE	2	11	18.2%	NO	0.003	0.53
FLUORANTHENE	3	17	17.6%	NO	0.38	0.65
HEPTACHLOR EPOXIDE	1	18	5.6%	NO	0.0021	0.0021
HEXAVALENT CHROMIUM	4	7	57.1%	NO	1.8	5
LEAD	17	17	100.0%	NO	5.5	35.5
MANGANESE	18	18	100.0%	NO	93.2	760
MERCURY	2	9	22.2%	NO	0.26	0.71
2-METHYLNAPHTHALENE	2	18	11.1%	NO	0.24	0.35
NAPHTHALENE	4	18	22.2%	NO	0.33	4.6
NICKEL	17	17	100.0%	NO	6.5	37.8
PHENANTHRENE	3	18	16.7%	NO	0.18	0.54
PYRENE	2	17	11.8%	NO	0.38	0.63
SELENIUM	1	8	12.5%	NO	1.1	1.1
STYRENE	1	11	9.1%	NO	0.009	0.009
TETRACHLOROETHENE	1	11	9.1%	NO	0.004	0.004
THALLIUM	1	8	12.5%	NO	1.9	1.9
TOLUENE	3	11	27.3%	NO	0.002	0.025
TRICHLOROETHENE	1	11	9.1%	NO	0.002	0.002
VANADIUM	18	18	100.0%	NO	4.6	43.9
VINYL CHLORIDE	1	11	9.1%	NO	0.043	0.043
XYLENE (TOTAL)	2	11	18.2%	NO	0.012	0.69
ZINC	18	18	100.0%	NO	27.6	105

a. PCOIs are indicated in **boldface** type.

TABLE 2

CHEMICALS DETECTED IN LAKE ERIE SURFACE SEDIMENT AND SELECTION OF PCOIs
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Parameter	Number of Detects	Total Number of Samples	Detection Frequency	Detection Frequency Less than or Equal to 5%?	Minimum Detected Concentrratio n (mg/kg)	Maximum Detected Concentrration (mg/kg)
2,4-Dimethylphenol	1	4	25%	NO	0.049	0.049
Bis(2-ethylhexyl)phthalat	3	4	75%	NO	0.1125	0.240
Carbazole	3	4	75%	NO	0.11	0.220
Dibenzofuran	3	4	75%	NO	0.1085	0.480
Acenaphthene	3	4	75%	NO	0.064	0.180
Acenaphthylene	3	4	75%	NO	0.095	0.430
Anthracene	4	4	100%	NO	0.078	1.10
Benzo(a)anthracene	4	4	100%	NO	0.056	2.10
Benzo(a)pyrene	3	4	75%	NO	0.395	1.60
Benzo(b)fluoranthene	4	4	100%	NO	0.053	2.10
Benzo(g,h,i)perylene	3	4	75%	NO	0.235	0.780
Benzo(k)fluoranthene	3	4	75%	NO	0.18	0.680
Chrysene	4	4	100%	NO	0.047	2.00
Dibenz(a,h)anthracene	3	4	75%	NO	0.077	0.370
Fluoranthene	4	4	100%	NO	0.2	4.60
Fluorene	4	4	100%	NO	0.067	0.920
Indeno(1,2,3-cd)pyrene	3	4	75%	NO	0.25	0.890
2-Methylnaphthalene	3	4	75%	NO	0.16	0.280
Naphthalene	4	4	100%	NO	0.044	5.15
Phenanthrene	4	4	100%	NO	0.26	3.00
Pyrene	4	4	100%	NO	0.18	2.90
Acetone	2	4	50%	NO	0.01075	0.013
Benzene	1	4	25%	NO	0.0045	0.005
Methylene Chloride	4	4	100%	NO	0.00225	0.006
Toluene	1	4	25%	NO	0.00225	0.002
Xylene (Total)	1	4	25%	NO	0.00325	0.003
4,4'-DDD	2	4	50%	NO	0.0019	0.003
4,4'-DDE	3	4	75%	NO	0.0007	0.002
4,4'-DDT	4	4	100%	NO	0.0005	0.006
Aldrin	1	4	25%	NO	0.000285	0.000
Alpha-Chlordane	2	4	50%	NO	0.00037	0.000
Dieldrin	3	4	75%	NO	0.0011	0.002
Endosulfan I	1	4	25%	NO	0.0002	0.000
Endosulfan Sulfate	3	4	75%	NO	0.00045	0.001
Endrin	1	4	25%	NO	0.00073	0.001
Endrin Aldehyde	2	4	50%	NO	0.00061	0.001
Endrin Ketone	2	4	50%	NO	0.0016	0.002
Gamma-Chlordane	3	4	75%	NO	0.00049	0.001
Heptachlor	1	4	25%	NO	0.00035	0.000
Heptachlor Epoxide	2	4	50%	NO	0.00039	0.000
Methoxychlor	4	4	100%	NO	0.0170	0.028

TABLE 2

CHEMICALS DETECTED IN LAKE ERIE SURFACE SEDIMENT AND SELECTION OF PCOIs
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Parameter	Number of Detects	Total Number of Samples	Detection Frequency	Detection Frequency Less than or Equal to 5%?	Minimum Detected Concentrration (mg/kg)	Maximum Detected Concentrration (mg/kg)
Aluminum	4	4	100%	NO	3940	6665
Antimony	4	4	100%	NO	1.8	2.30
Arsenic	4	4	100%	NO	10.8	12.8
Barium	4	4	100%	NO	22.2	40.4
Beryllium	4	4	100%	NO	0.2	0.370
Cadmium	1	4	25%	NO	0.1925	0.193
Chromium, Total	4	4	100%	NO	9.4	39.6
Cobalt	4	4	100%	NO	7.7	8.80
Copper	4	4	100%	NO	18.7	27.0
Cyanide	2	4	50%	NO	0.77	1.57
Lead	4	4	100%	NO	11.8	22.7
Manganese	4	4	100%	NO	331	402
Mercury	4	4	100%	NO	0.014	0.100
Nickel	4	4	100%	NO	17.8	22.1
Silver	1	4	25%	NO	0.11	0.110
Thallium	2	4	50%	NO	1.275	1.60
Vanadium	4	4	100%	NO	5.5	9.80
Zinc	4	4	100%	NO	89.8	116

a. PCOIs are indicated in **boldface** type.

TABLE 3
CHEMICALS DETECTED IN GRAND RIVER SURFACE WATER AND SELECTION OF PCOIs[a]

Parameter	Number of Detects	Total Number of Samples	Detection Frequency	Detection Frequency Less than or Equal to 5%?	Human Essential Nutrient?	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)
CALCIUM	132	132	100.0%	NO	YES	37.8	472
CHLORIDE[b]	132	132	100.0%	NO	NO	53	1,230.00
CHROMIUM	242	305	79.3%	NO	NO	0.0012	0.22
HEXAVALENT CHROMIUM	178	295	60.3%	NO	NO	0.002	0.039
HEXAVALENT CHROMIUM, FILTERED	236	300	78.7%	NO	NO	0.003	0.228
MAGNESIUM	132	132	100.0%	NO	YES	8.57	18.2
SODIUM	132	132	100.0%	NO	YES	31.5	278

a. PCOIs are indicated in **boldface** type.

b. These chemicals are typically not evaluated for human health effects and are therefore not evaluated in this Baseline Human Health Risk Assessment. These are evaluated, however, for impacts to ecological receptors including aquatic life in the Baseline Ecological Risk Assessment.

TABLE 4

SELECTION OF COIs IN GRAND RIVER SEDIMENT*

Parameter	Maximum Sediment Detected Concentration (mg/kg)	Region 9 PRG, Residential Soil (mg/kg)	Exceed Region IX PRG - Residential ?
ALUMINUM	17600	7600	**YES**
ANTIMONY	4	3.1	**YES**
ARSENIC	52.3	0.39	**YES**
BARIUM	440	540	NO
BENZENE	0.19	0.6	NO
BENZO(A)ANTHRACENE	0.36	0.62	NO
BERYLLIUM	3	15	NO
BIS(2-ETHYLHEXYL)PHTHALATE	0.7	35	NO
BUTYLBENZYLPHTHALATE	0.41	1200	NO
CADMIUM	1.9	3.7	NO
CARBON DISULFIDE	0.002	36	NO
CARBON TETRACHLORIDE	0.003	0.25	NO
CHLOROBENZENE	0.092	15	NO
CHROMIUM	111	210	NO
CHRYSENE	0.38	62	NO
COBALT	14.6	900	NO
COPPER	33	310	NO
CYANIDE	2.7	1.1	**YES**
4,4'-DDD	0.0036	2.4	NO
1,2-DICHLOROETHANE	0.01	0.28	NO
1,2-DICHLOROETHENE(TOTAL)	0.033	4.3	NO
ETHYLBENZENE	0.53	8.9	NO
FLUORANTHENE	0.65	230	NO
HEPTACHLOR EPOXIDE	0.0021	0.053	NO
HEXAVALENT CHROMIUM	5	30	NO
LEAD	35.5	40	NO
MANGANESE	760	180	**YES**
MERCURY	0.71	2.3	NO
2-METHYLNAPHTHALENE[f]	0.35	5.6	NO
NAPHTHALENE	4.6	5.6	NO
NICKEL	37.8	160	NO
PHENANTHRENE[h]	0.54	2200	NO
PYRENE	0.63	230	NO
SELENIUM	1.1	39	NO
STYRENE[g]	0.009	1700	NO
TETRACHLOROETHENE	0.004	1.5	NO
THALLIUM	1.9	0.52	**YES**
TOLUENE[g]	0.025	520	NO
TRICHLOROETHENE	0.002	0.053	NO
VANADIUM	43.9	55	NO
VINYL CHLORIDE	0.043	0.079	NO
XYLENE (TOTAL)	0.69	27	NO
ZINC	105	2300	NO

* COIs are indicated in **boldface** type.

PRGs are U.S. EPA Region 9 Preliminary Remediation Goals (U.S. EPA, 2002).

a. The PRG for acenapthene was used.

b. The PRG for pyrene was used.

d The PRG for Endosulfan was used.

e The PRG for Endrin was used.

f. The PRG for naphthalene was used.

g. PRG based on the soil saturation limit.

h. The PRG for anthracene was used.

TABLE 5

SELECTION OF COIs IN IN LAKE ERIE SEDIMENT
(Page 1 of 2)

Parameter	Maximum Detected Concentration (mg/kg)	Region 9 PRG, Residential Soil (mg/kg)	Exceed Region IX PRG - Residential ?
2,4-Dimethylphenol	0.049	120	NO
Bis(2-ethylhexyl)phthalate	0.240	35	NO
Carbazole	0.220	24	NO
Dibenzofuran	0.480	29	NO
Acenaphthene	0.180	370	NO
Acenaphthylene[b]	0.430	370	NO
Anthracene	1.10	2200	NO
Benzo(a)anthracene	**2.10**	**0.62**	**YES**
Benzo(a)pyrene	**1.60**	**0.062**	**YES**
Benzo(b)fluoranthene	**2.10**	**0.62**	**YES**
Benzo(g,h,i)perylene[c]	0.780	230	NO
Benzo(k)fluoranthene	0.680	6.2	NO
Chrysene	2.00	62	NO
Dibenz(a,h)anthracene	**0.370**	**0.062**	**YES**
Fluoranthene	4.60	230	NO
Fluorene	0.920	270	NO
Indeno(1,2,3-cd)pyrene	**0.890**	**0.62**	**YES**
2-Methylnaphthalene[d]	0.280	5.6	NO
Naphthalene	5.15	5.6	NO
Phenanthrene[e]	3.00	2200	NO
Pyrene	2.90	230	NO
Total PAHs	24.3	0	YES
Acetone	0.013	160	NO
Benzene	0.005	0.6	NO
Methylene Chloride	0.006	9.1	NO
Toluene	0.002	520	NO
Xylene (Total)	0.003	27	NO
4,4'-DDD	0.003	2.4	NO
4,4'-DDE	0.002	1.7	NO
4,4'-DDT	0.006	1.7	NO
Aldrin	0.000	0.029	NO
Alpha-Chlordane[f]	0.000	1.6	NO
Dieldrin	0.002	0.03	NO
Endosulfan I[g]	0.00023	37	NO
Endosulfan Sulfate[g]	0.001	37	NO
Endrin	0.001	1.8	NO
Endrin Aldehyde[h]	0.001	1.8	NO
Endrin Ketone[h]	0.002	1.8	NO
Gamma-Chlordane[i]	0.001	1.6	NO
Heptachlor	0.0004	0.11	NO
Heptachlor Epoxide	0.0004	0.053	NO
Methoxychlor	0.028	31	NO

TABLE 5

SELECTION OF COIs IN IN LAKE ERIE SEDIMENT
(Page 2 of 2)

Parameter	Maximum Detected Concentration (mg/kg)	Region 9 PRG, Residential Soil (mg/kg)	Exceed Region IX PRG - Residential ?
Aluminum	6665	7600	NO
Antimony	2.30	3.1	NO
Arsenic	**12.8**	**0.39**	**YES**
Barium	40.4	540	NO
Beryllium	0.370	15	NO
Cadmium	0.193	3.7	NO
Chromium, Total	39.6	210	NO
Cobalt	8.80	900	NO
Copper	27.0	310	NO
Cyanide	1.57	120	NO
Lead	22.7	40	NO
Manganese	**402**	**180**	**YES**
Mercury	0.100	0.61	NO
Nickel	22.1	160	NO
Silver	0.110	39	NO
Thallium	**1.60**	**0.52**	**YES**
Vanadium	9.80	55	NO
Zinc	116	2300	NO

U.S. EPA Region 9 PRGs (U.S. EPA, 2002)

a. PCOIs are indicated in **boldface** type.

b. The PRG for acenapthene was used.

c. The PRG for pyrene was used.

d. The PRG for naphthalene was used.

e. The PRG for anthracene was used.

f. The PRG for chlordane was used.

g. The PRG for endosulfan was used.

h. The PRG for endrin was used.

TABLE 6
SELECTION OF COIs IN GRAND RIVER SURFACE WATER - FISH INGESTION*

Parameter	Maximum Detected Concentration (mg/L)	Lake Erie Drainage Basin Surface Water Human Health Criteria[a] (mg/L)	Maximum Detect Exceed Human Health Criteria?
CHROMIUM	0.22	14	NO
HEXAVALENT CHROMIUM[b]	0.039	14	NO
HEXAVALENT CHROMIUM, FILTERED[b]	0.228	14	NO

* COIs are indicated in **boldface** type.

a. OEPA Human health nondrinking water criteria for the Lake Erie drainage basin based on a one-route exposure through fish ingestion only per OAC 3745-1-33 (OEPA, 2002).

b. HH Nondrink criteria listed is for dissolved hexavalent chromium

c. This values is based on a carcinogenic endpoint

d. "ID" indicates insufficient data was available to develop criteria.

TABLE 7

SUMMARY STATISTICS AND EPCs FOR CHEMICALS OF INTEREST IN GRAND RIVER SEDIMENT (MG/KG

Parameter	Number of Detects	Total Number of Samples	Detection Frequency	Minimum Detected Concentration	Maximum Detected Concentration	Statistics[a] Distribution[b]	Mean	Standard Deviation	95% UCL (Normal)[c]	95% UCL (Log)[c]	RME EPC[d]
ALUMINUM	18	18	100.0%	3020	17600	LOGNORMAL	6904.7	4761	8856.9	9256.1	9256
ANTIMONY	1	8	12.5%	4	4	UNKNOWN	NA	NA	NA	NA	4
ARSENIC	12	18	66.7%	7.7	52.3	UNKNOWN	11.8	10.8	16.2	15.7	15.7
CYANIDE	5	5	100.0%	0.76	2.7	UNKNOWN	1.6	0.88	2.5	NA	2.7
MANGANESE	18	18	100.0%	93.2	760	LOGNORMAL	221.7	154	284.8	286.5	286
THALLIUM	1	8	12.5%	1.9	1.9	UNKNOWN	NA	NA	NA	NA	1.9

a. Statistics were calculated using one half the method detection limit for nondetects.
b. Distributions were "unknown" if N<8 or detection frequency <50% or does not fit a normal or lognormal distribution. "Unknown" distributions were considered lognormal.
c. 95% UCL = 95% Upper Confidence Limit. See text for description of calculation methodology.
d. RME EPC = Reasonable Maximum Exposure Concentration based on either normal 95% UCL or lognormal 95% UCL, depending on distribution type.
NA = Not applicable, value exceeds the maximum detected concentration

TABLE 8
SUMMARY STATISTICS AND EPCs FOR CHEMICALS OF INTEREST IN LAKE ERIE SEDIMENT (MG/KG)

Chemical	Number of Detects	Total Number of Samples	Detection Frequency	Minimum Detected Concentration	Maximum Detected Concentration	Statsitcs[a]					
						Distribution[a]	Arithmetic Mean	Arithmetic SD[b]	95% UCL Normal	95% UCL Lognormal	RME EPC[d]
Benzo(a)anthracene	4	4	100%	0.056	2.1	Not Determined	0.904	0.867	1.924183998	NA	2.1
Benzo(a)pyrene	3	4	75%	0.395	1.6	Not Determined	0.673875	0.674	1.466838211	NA	1.6
Benzo(b)fluoranthene	4	4	100%	0.053	2.1	Not Determined	0.90575	0.870	1.929976003	NA	2.1
Dibenzo(a,h)anthracene	3	4	75%	0.077	0.37	Not Determined	0.16175	0.154	0.342668688	NA	0.37
Indeno(1,2,3-cd)pyrene	3	4	75%	0.25	0.89	Not Determined	0.402625	0.369	0.837144388	NA	0.89
Arsenic	4	4	100%	10.8	12.75	Not Determined	11.813	0.798	NA	NA	12.75
Manganese	4	4	100%	331	402	Not Determined	353.1250	33.4	392.393899	NA	402
Thallium	2	4	50%	1.275	1.6	Not Determined	0.9650	0.562	NA	NA	1.6

a. Statistics were calculated using one half the method detection limit for nondetects.

b. Distributions were "not determined" because N<8.

c. 95% UCL = 95% Upper Confidence Limit. See text for description of calculation methodology.

d. RME EPC = Reasonable Maximum Exposure Concentration based on either normal 95% UCL or lognormal 95% UCL, depending on distribution type.

NA = Not applicable, value exceeds the maximum detected concentration.

..ABLE 9
SUMMARY STATISTICS AND EPCs FOR CHEMICALS OF INTEREST IN GRAND RIVER SURFACE WATER (MG/L)

Parameter	Number of Detects	Total Number of Samples	Detection Frequency	Minimum Detected Concentration	Maximum Detected Concentration	Statistics[a]					
						Distribution[b]	Mean	Standard Deviation	95% UCL (Normal)[c]	95% UCL (Log)[c]	RME EPC[d]
CHROMIUM	242	305	79.3%	0.0012	0.22	UNKNOWN	0.012	0.018	0.013	0.015	0.015
HEXAVALENT CHROMIUM	178	295	60.3%	0.002	0.039	UNKNOWN	0.009	0.009	0.009	0.011	0.011
HEXAVALENT CHROMIUM, FILTERED	236	300	78.7%	0.003	0.228	UNKNOWN	0.013	0.018	0.013	0.014	0.014

* COIs are presented in **boldface** type. Although not a COI, chromium was quantified for the fish ingestion pathway.

a. Statistics were calculated using one half the method detection limit for nondetects.

b. Distributions were "unknown" if N<8 or detection frequency <50% or does not fit a normal or lognormal distribution. "Unknown" distributions were considered lognormal.

c. 95% UCL = 95% Upper Confidence Limit. See text for description of calculation methodology.

d. RME EPC = Reasonable Maximum Exposure Concentration based on either normal 95% UCL or lognormal 95% UCL, depending on distribution type.

NA = Not applicable, value exceeds the maximum detected concentration or insufficient number of data points were available.

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 10

Summary of Chemical Specific Data

Chemical of Concern	Grand River EPCs: Sediment (mg/kg)	Grand River EPCs: Surface Water (mg/l)	Grand River EPCs: Fish Tissue (mg/kg)	Dermal Absorbtion Adjustments: Sediment ABS	Dermal Absorbtion Adjustments: Surface Water PC	Toxicity Data: RfDo mg/kg-day	Toxicity Data: RfDd mg/kg-day	Toxicity Data: SFo $(mg/kg\text{-}day)^{-1}$	Toxicity Data: SFd $(mg/kg\text{-}day)^{-1}$
Aluminum	9256.1 a			0.01	1.00E-03	1.00E+00 n	1.00E+00 r	0.00E+00	0.00E+00
Antimony	4 b			0.01	1.00E-03	4.00E-04 i	4.00E-04 r	0.00E+00	0.00E+00
Arsenic	15.7 a			0.03	1.00E-03	3.00E-04 i	3.00E-04 r	1.50E+00 i	1.50E+00 r
Barium				0.01	1.00E-03	7.00E-02 i	7.00E-02 r	0.00E+00	0.00E+00
Chromium III		0.22 b,c	4.18 d	0.01	1.00E-03	1.50E+00 i	1.50E-02 r	0.00E+00	0.00E+00
Chromium VI		0.228 b		0.01	1.00E-03	3.00E-03 i	3.00E-04 r	0.00E+00	0.00E+00
Cobalt				0.01	1.00E-03	2.00E-02 n	2.00E-02 r	0.00E+00	0.00E+00
Copper				0.01	1.00E-03	3.71E-02 h	3.71E-02 r	0.00E+00	0.00E+00
Methylene Chloride				0.01	4.50E-03	6.00E-02 i	6.00E-02 r	7.50E-03 i	7.50E-03 r
Manganese	286.5 a			0.01	1.00E-03	2.40E-02 i	2.40E-02 r	0.00E+00	0.00E+00
Mercury (methyl)				0.01	1.00E-03	1.00E-04 i	1.50E-05 r	0.00E+00 0	0.00E+00
Nickel				0.01	1.00E-03	2.00E-02 i	6.00E-04 r	0.00E+00	0.00E+00
Selenium				0.01	1.00E-03	5.00E-03 i	5.00E-03 r	0.00E+00	0.00E+00
Thallium	1.9 b			0.01	1.00E-03	8.00E-05 i	8.00E-05 r	0.00E+00	0.00E+00
Zinc				0.01	1.00E-03	3.00E-01 i	9.00E-02 r	0.00E+00	0.00E+00
Cyanide	2.7 b			0.01	1.00E-03	2.00E-02 i	2.00E-02 r	0.00E+00	0.00E+00
Benz[a]anthracene				0.13	1.00E-03	0.00E+00	0.00E+00 r	7.30E-01 n	7.30E-01
Benzo[a]pyrene				0.13	1.00E-03	0.00E+00	0.00E+00 r	7.30E+00 i	7.30E+00
Benzo[b]fluoranthene				0.13	1.00E-03	0.00E+00	0.00E+00 r	7.30E-01 n	7.30E-01
Dibenz[ah]anthracene				0.13	1.00E-03	0.00E+00	0.00E+00 r	7.30E+00 n	7.30E+00
Indeno[1,2,3-cd]pyrene				0.13	1.00E-03	0.00E+00	0.00E+00 r	7.30E-01 n	7.30E-01

Exposure Point Concentration Notes

a 95% UCL
b maximum detected concentration
c concentration reported as total
d surf. water conc. x 19 (BCF)
e surf. water conc. x 5000 (BCF)

Absorbtion Notes

Sediment ABS taken from U.S. EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, 2001. Surface water PC values are from U.S. EPA Dermal Assessment Guidance, 1992.

Toxicity Data Notes

i IRIS
h HEAST
n NCEA
r Route-to-route extrapolation - Oral absorption factors for adjustment of extrapolated toxicity criteria:

1.0 default	0.15 mercury
0.05 cadmium	0.03 nickel
0.01 chromium III	0.3 zinc
0.1 chromium VI	0.9 phenol

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 11

Exposure Factor Values for Human Health Risk Assessment

Exposure Factor	Grand River Recreators			
	Adult		Child	
BW - Body Weight (kg)	70	a	15	a
ATc - Averaging Time Carcinogenic (days)	25550	a	25550	a
ATn - Averaging Time Non-Carcinogenic (days)	8760	a	2190	a
ED - Exposure Duration (years)	24	b	6	b
EFfish - Exposure Frequency Fish Consumption (days/yr)	365	c	365	c
EF - Exposure Frequency (days/yr)	90	b	90	b
EFsw - Surface Water Ingestion (events/yr)	90	b	90	b
IRsed - Ingestion Rate Sediments (mg/day)	100	b	200	b
IRsw - Ingestion Rate Surface Water (L/event)	0.05	a	0.05	a
IRfish - Ingestion Rate Fish (mg/day)	32000	c	5300	c
AF - Soil to Skin Adherence Factor (mg/cm2)	0.3	c	0.3	c
SA - Surface Area of Exposed Skin (cm2/day)	5700	b	2900	b
ET - Exposure Time in Surface Water (hr/day)	2	a	2	a

References:
a Risk Assessment Guidance for Superfund, U.S. EPA, 1989.
b EPA approved value.
c Exposure Factors Handbook, U.S. EPA, 1997.

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 12

Ingestion of COIs in Fish from Grand River

$$LADD = \frac{C_{fish} \times IR_{fish} \times CF \times EF_{fish} \times ED}{BW \times ATc}$$

$$Risk = LADD \times SF_{oral}$$

$$CADD = \frac{C_{fish} \times IR_{fish} \times CF \times EF_{fish} \times ED}{BW \times ATn}$$

$$Hazard = \frac{CADD}{RfD_{oral}}$$

Adult

Chemical	Cfish mg/kg	IRfish mg/day	CF kg/mg	EFfish days/yr	ED yr	BW kg	ATn days	ATc days	CADD mg/kg-day	LADD mg/kg-day	RfDoral mg/kg-day	SForal (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	4.00E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-04	1.50E+00	0.00E+00	0.00E+00
Barium	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	4.18	32000	1.00E-06	365	24	70	8760	25550	1.91E-03	6.55E-04	1.50E+00	0.00E+00	1.27E-03	0.00E+00
Chromium VI	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00
Cobalt	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Mercury (methyl)	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00
Nickel	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Selenium	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	8.00E-05	0.00E+00	0.00E+00	0.00E+00
Zinc	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00	0.00E+00
Cyanide	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Benz[a]anthracene	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	32000	1.00E-06	365	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Child

Chemical	Cfish mg/kg	IRfish mg/day	CF kg/mg	EFfish days/yr	ED yr	BW kg	ATn days	ATc days	CADD mg/kg-day	LADD mg/kg-day	RfDoral mg/kg-day	SForal (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	4.00E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-04	1.50E+00	0.00E+00	0.00E+00
Barium	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	4.18	5300	1.00E-06	365	6	15	2190	25550	1.48E-03	1.27E-04	1.50E+00	0.00E+00	9.85E-04	0.00E+00
Chromium VI	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00
Cobalt	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Mercury (methyl)	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00
Nickel	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Selenium	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	8.00E-05	0.00E+00	0.00E+00	0.00E+00
Zinc	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00	0.00E+00
Cyanide	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Benz[a]anthracene	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	5300	1.00E-06	365	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 13

Ingestion of COIs in Grand River Sediments

$$LADD = \frac{C_{sed} \times IR_{sed} \times CF \times EF \times ED}{BW \times ATc}$$

$$Risk = LADD \times SF_{oral}$$

$$CADD = \frac{C_{sed} \times IR_{sed} \times CF \times EF \times ED}{BW \times ATn}$$

$$Hazard = \frac{CADD}{RfD_{oral}}$$

Adult

Chemical	Csed mg/kg	IRsed mg/day	CF kg/mg	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADD mg/kg-day	LADD mg/kg-day	RfDoral mg/kg-day	SForal $(mg/kg\text{-}day)^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	9256.1	100	1.00E-06	90	24	70	8760	25550	3.26E-03	1.12E-03	1.00E+00	0.00E+00	3.26E-03	0.00E+00
Antimony	4	100	1.00E-06	90	24	70	8760	25550	1.41E-06	4.83E-07	4.00E-04	0.00E+00	3.52E-03	0.00E+00
Arsenic	15.7	100	1.00E-06	90	24	70	8760	25550	5.53E-06	1.90E-06	3.00E-04	1.50E+00	1.84E-02	2.84E-06
Barium	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	1.50E+00	0.00E+00	0.00E+00	0.00E+00
Chromium VI	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00
Cobalt	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	286.5	100	1.00E-06	90	24	70	8760	25550	1.01E-04	3.48E-05	2.40E-02	0.00E+00	4.20E-03	0.00E+00
Mercury (methyl)	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00
Nickel	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Selenium	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	1.9	100	1.00E-06	90	24	70	8760	25550	6.69E-07	2.29E-07	8.00E-05	0.00E+00	8.37E-03	0.00E+00
Zinc	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.7	100	1.00E-06	90	24	70	8760	25550	9.51E-07	3.26E-07	2.00E-02	0.00E+00	4.76E-05	0.00E+00
Benz[a]anthracene	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	100	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Child

Chemical	Csed mg/kg	IRsed mg/day	CF kg/mg	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADD mg/kg-day	LADD mg/kg-day	RfDoral mg/kg-day	SForal $(mg/kg\text{-}day)^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	9256.1	200	1.00E-06	90	6	15	2190	25550	3.04E-02	2.61E-03	1.00E+00	0.00E+00	3.04E-02	0.00E+00
Antimony	4	200	1.00E-06	90	6	15	2190	25550	1.32E-05	1.13E-06	4.00E-04	0.00E+00	3.29E-02	0.00E+00
Arsenic	15.7	200	1.00E-06	90	6	15	2190	25550	5.16E-05	4.42E-06	3.00E-04	1.50E+00	1.72E-01	6.64E-06
Barium	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	1.50E+00	0.00E+00	0.00E+00	0.00E+00
Chromium VI	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00
Cobalt	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	286.5	200	1.00E-06	90	6	15	2190	25550	9.42E-04	8.07E-05	2.40E-02	0.00E+00	3.92E-02	0.00E+00
Mercury (methyl)	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00
Nickel	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Selenium	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	1.9	200	1.00E-06	90	6	15	2190	25550	6.25E-06	5.35E-07	8.00E-05	0.00E+00	7.81E-02	0.00E+00
Zinc	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.7	200	1.00E-06	90	6	15	2190	25550	8.88E-06	7.61E-07	2.00E-02	0.00E+00	4.44E-04	0.00E+00
Benz[a]anthracene	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	200	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 14

Dermal Contact with COIs in Grand River Sediments

$$LADAD = \frac{C_{sed} \times AF \times ABS \times SA \times CF \times EF \times ED}{BW \times ATc}$$

$$Risk = LADAD \times SF_{derm}$$

$$CADAD = \frac{C_{sed} \times AF \times ABS \times SA \times CF \times EF \times ED}{BW \times ATn}$$

$$Hazard = \frac{CADAD}{RfD_{derm}}$$

Adult

Chemical	Csed mg/kg	AF mg/cm2	ABS dimesionless	SA cm2/day	CF kg/mg	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADAD mg/kg-day	LADAD mg/kg-day	RfDderm mg/kg-day	SFderm (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	9256.1	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	5.58E-04	1.91E-04	1.00E+00	0.00E+00	5.58E-04	0.00E+00
Antimony	4	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	2.41E-07	8.26E-08	4.00E-04	0.00E+00	6.02E-04	0.00E+00
Arsenic	15.7	0.3	0.03	5700	1.00E-06	90	24	70	8760	25550	2.84E-06	9.73E-07	3.00E-04	1.50E+00	9.46E-03	1.46E-06
Barium	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	1.50E-02	0.00E+00	0.00E+00	0.00E+00
Chromium VI	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-04	0.00E+00	0.00E+00	0.00E+00
Cobalt	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	286.5	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	1.73E-05	5.92E-06	2.40E-02	0.00E+00	7.19E-04	0.00E+00
Mercury (methyl)	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	1.50E-05	0.00E+00	0.00E+00	0.00E+00
Nickel	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	6.00E-04	0.00E+00	0.00E+00	0.00E+00
Selenium	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	1.9	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	1.14E-07	3.92E-08	8.00E-05	0.00E+00	1.43E-03	0.00E+00
Zinc	0	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	9.00E-02	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.7	0.3	0.01	5700	1.00E-06	90	24	70	8760	25550	1.63E-07	5.58E-08	2.00E-02	0.00E+00	8.13E-06	0.00E+00
Benz[a]anthracene	0	0.3	0.13	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	0.3	0.13	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	0.3	0.13	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	0.3	0.13	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	0.3	0.13	5700	1.00E-06	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Child

Chemical	Csed mg/kg	AF mg/cm2	ABS dimesionless	SA cm2/day	CF kg/mg	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADAD mg/kg-day	LADAD mg/kg-day	RfDderm mg/kg-day	SFerm (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	9256.1	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	1.32E-03	1.13E-04	1.00E+00	0.00E+00	1.32E-03	0.00E+00
Antimony	4	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	5.72E-07	4.90E-08	4.00E-04	0.00E+00	1.43E-03	0.00E+00
Arsenic	15.7	0.3	0.03	2900	1.00E-06	90	6	15	2190	25550	6.74E-06	5.77E-07	3.00E-04	1.50E+00	2.25E-02	8.66E-07
Barium	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	1.50E-02	0.00E+00	0.00E+00	0.00E+00
Chromium VI	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-04	0.00E+00	0.00E+00	0.00E+00
Cobalt	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	286.5	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	4.10E-05	3.51E-06	2.40E-02	0.00E+00	1.71E-03	0.00E+00
Mercury (methyl)	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	1.50E-05	0.00E+00	0.00E+00	0.00E+00
Nickel	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	6.00E-04	0.00E+00	0.00E+00	0.00E+00
Selenium	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	1.9	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	2.72E-07	2.33E-08	8.00E-05	0.00E+00	3.40E-03	0.00E+00
Zinc	0	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	9.00E-02	0.00E+00	0.00E+00	0.00E+00
Cyanide	2.7	0.3	0.01	2900	1.00E-06	90	6	15	2190	25550	3.86E-07	3.31E-08	2.00E-02	0.00E+00	1.93E-05	0.00E+00
Benz[a]anthracene	0	0.3	0.13	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	0.3	0.13	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	0.3	0.13	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	0.3	0.13	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	0.3	0.13	2900	1.00E-06	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 15

Ingestion of COIs in Grand River Surface Water

$$LADD = \frac{Csw \times IRsw \times EF \times ED}{BW \times ATc} \qquad RISK = LADD \times SForal$$

$$CADD = \frac{Csw \times IRsw \times EF \times ED}{BW \times ATn} \qquad HAZARD = \frac{CADD}{RfDoral}$$

Adult

Chemical	Csw mg/L	IRsw L/event	EF events/yr	ED yr	BW kg	ATn days	ATc days	CADD mg/kg-day	LADD mg/kg-day	RfDoral mg/kg-day	SForal (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	4.00E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-04	1.50E+00	0.00E+00	0.00E+00
Barium	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0.22	0.05	90	24	70	8760	25550	3.87E-05	1.33E-05	1.50E+00	0.00E+00	2.58E-05	0.00E+00
Chromium VI	0.228	0.05	90	24	70	8760	25550	4.02E-05	1.38E-05	3.00E-03	0.00E+00	1.34E-02	0.00E+00
Cobalt	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Mercury (methyl)	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00
Nickel	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Selenium	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	8.00E-05	0.00E+00	0.00E+00	0.00E+00
Zinc	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00	0.00E+00
Cyanide	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Benz[a]anthracene	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	0.05	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Child

Chemical	Csw mg/L	IRsw L/hr	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADD mg/kg-day	LADD mg/kg-day	RfDoral mg/kg-day	SForal (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	4.00E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-04	1.50E+00	0.00E+00	0.00E+00
Barium	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0.22	0.05	90	6	15	2190	25550	1.81E-04	1.55E-05	1.50E+00	0.00E+00	1.21E-04	0.00E+00
Chromium VI	0.228	0.05	90	6	15	2190	25550	1.87E-04	1.61E-05	3.00E-03	0.00E+00	6.25E-02	0.00E+00
Cobalt	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Mercury (methyl)	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	1.00E-04	0.00E+00	0.00E+00	0.00E+00
Nickel	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Selenium	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	8.00E-05	0.00E+00	0.00E+00	0.00E+00
Zinc	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00	0.00E+00
Cyanide	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Benz[a]anthracene	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	0.05	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 16

Dermal Contact with COIs in Grand River Surface Water

$$LADAD = \frac{C_{sw} \times PC \times ET \times SA \times CF \times EF \times ED}{BW \times ATc}$$

$$Risk = LADAD \times SF_{derm}$$

$$CADAD = \frac{C_{sw} \times PC \times ET \times SA \times CF \times EF \times ED}{BW \times ATn}$$

$$Hazard = \frac{CADAD}{RfD_{derm}}$$

Adult

Chemical	CW mg/L	PC cm/hr	ET hr/day	SA cm2	CF cm3/L	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADAD mg/kg-day	LADAD mg/kg-day	RfDderm mg/kg-day	SFderm (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	4.00E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	3.00E-04	1.50E+00	0.00E+00	0.00E+00
Barium	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0.22	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	8.83E-06	3.03E-06	1.50E-02	0.00E+00	5.89E-04	0.00E+00
Chromium VI	0.228	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	9.16E-06	3.14E-06	3.00E-04	0.00E+00	3.05E-02	0.00E+00
Cobalt	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	4.50E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Mercury (methyl)	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	1.50E-05	0.00E+00	0.00E+00	0.00E+00
Nickel	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	8.00E-04	0.00E+00	0.00E+00	0.00E+00
Selenium	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	8.00E-05	0.00E+00	0.00E+00	0.00E+00
Zinc	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	9.00E-02	0.00E+00	0.00E+00	0.00E+00
Cyanide	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Benz[a]anthracene	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	1.00E-03	2	5700	1.00E-03	90	24	70	8760	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Child

Chemical	CW mg/L	PC cm/hr	ET hr/day	SA cm2	CF cm3/L	EF days/yr	ED yr	BW kg	ATn days	ATc days	CADAD mg/kg-day	LADAD mg/kg-day	RfDderm mg/kg-day	SFerm (mg/kg-day)$^{-1}$	Hazard dimensionless	Risk dimensionless
Aluminum	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	4.00E-04	0.00E+00	0.00E+00	0.00E+00
Arsenic	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	3.00E-04	1.50E+00	0.00E+00	0.00E+00
Barium	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00
Chromium III	0.22	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	2.10E-05	1.80E-06	1.50E-02	0.00E+00	1.40E-03	0.00E+00
Chromium VI	0.228	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	2.17E-05	1.86E-06	3.00E-04	0.00E+00	7.25E-02	0.00E+00
Cobalt	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Copper	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	3.71E-02	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0	4.50E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	6.00E-02	7.50E-03	0.00E+00	0.00E+00
Manganese	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	0.00E+00
Mercury (methyl)	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	1.50E-05	0.00E+00	0.00E+00	0.00E+00
Nickel	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	8.00E-04	0.00E+00	0.00E+00	0.00E+00
Selenium	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	5.00E-03	0.00E+00	0.00E+00	0.00E+00
Thallium	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	8.00E-05	0.00E+00	0.00E+00	0.00E+00
Zinc	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	9.00E-02	0.00E+00	0.00E+00	0.00E+00
Cyanide	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00
Benz[a]anthracene	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Benzo[a]pyrene	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00
Dibenz[ah]anthracene	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E+00	0.00E+00	0.00E+00
Indeno[1,2,3-cd]pyrene	0	1.00E-03	2	2900	1.00E-03	90	6	15	2190	25550	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	0.00E+00

Diamond Shamrock Painesville Works Site
Lake Erie and Grand River Baseline Human Health Risk Assessment

Table 17

Summary of Calculated Noncancer Hazards for the Grand River

Adult

Chemical of Concern	Fish Ingestion	Sediment Ingestion	Sediment Dermal	Surface Water Ingestion	Surface Water Dermal	COI Total
Aluminum	0.0E+00	3.3E-03	5.6E-04	0.0E+00	0.0E+00	3.8E-03
Antimony	0.0E+00	3.5E-03	6.0E-04	0.0E+00	0.0E+00	4.1E-03
Arsenic	0.0E+00	1.8E-02	9.5E-03	0.0E+00	0.0E+00	2.8E-02
Barium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium III	1.3E-03	0.0E+00	0.0E+00	2.6E-05	5.9E-04	1.9E-03
Chromium VI	0.0E+00	0.0E+00	0.0E+00	1.3E-02	3.1E-02	4.4E-02
Cobalt	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Methylene Chloride	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Manganese	0.0E+00	4.2E-03	7.2E-04	0.0E+00	0.0E+00	4.9E-03
Mercury (methyl)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nickel	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Selenium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Thallium	0.0E+00	8.4E-03	1.4E-03	0.0E+00	0.0E+00	9.8E-03
Zinc	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cyanide	0.0E+00	4.8E-05	8.1E-06	0.0E+00	0.0E+00	5.6E-05
Benz[a]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[a]pyrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[b]fluoranthene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dibenz[ah]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Indeno[1,2,3-cd]pyren	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pathway Total	1.3E-03	3.8E-02	1.3E-02	1.3E-02	3.1E-02	**0.1**

Child

Chemical of Concern	Fish Ingestion	Sediment Ingestion	Sediment Dermal	Surface Water Ingestion	Surface Water Dermal	COI Total
Aluminum	0.0E+00	3.0E-02	1.3E-03	0.0E+00	0.0E+00	3.2E-02
Antimony	0.0E+00	3.3E-02	1.4E-03	0.0E+00	0.0E+00	3.4E-02
Arsenic	0.0E+00	1.7E-01	2.2E-02	0.0E+00	0.0E+00	1.9E-01
Barium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium III	9.8E-04	0.0E+00	0.0E+00	1.2E-04	1.4E-03	2.5E-03
Chromium VI	0.0E+00	0.0E+00	0.0E+00	6.2E-02	7.2E-02	1.3E-01
Cobalt	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Methylene Chloride	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Manganese	0.0E+00	3.9E-02	1.7E-03	0.0E+00	0.0E+00	4.1E-02
Mercury (methyl)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nickel	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Selenium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Thallium	0.0E+00	7.8E-02	3.4E-03	0.0E+00	0.0E+00	8.1E-02
Zinc	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cyanide	0.0E+00	4.4E-04	1.9E-05	0.0E+00	0.0E+00	4.6E-04
Benz[a]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[a]pyrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[b]fluoranthene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dibenz[ah]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Indeno[1,2,3-cd]pyren	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pathway Total	9.8E-04	3.5E-01	3.0E-02	6.3E-02	7.4E-02	**0.5**

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Table 18

Summary of Calculated Cancer Risks for the Grand River

Adult

Chemical of Concern	Fish Ingestion	Sediment Ingestion	Sediment Dermal	Surface Water Ingestion	Surface Water Dermal	COI Total
Aluminum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Antimony	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Arsenic	0.0E+00	2.8E-06	1.5E-06	0.0E+00	0.0E+00	4.3E-06
Barium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium III	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium VI	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cobalt	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Methylene Chloride	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Manganese	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Mercury (methyl)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nickel	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Selenium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Thallium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zinc	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cyanide	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benz[a]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[a]pyrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[b]fluoranthene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dibenz[ah]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Indeno[1,2,3-cd]pyrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pathway Total	0.0E+00	2.8E-06	1.5E-06	0.0E+00	0.0E+00	**4.3E-06**

Child

Chemical of Concern	Fish Ingestion	Sediment Ingestion	Sediment Dermal	Surface Water Ingestion	Surface Water Dermal	COI Total
Aluminum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Antimony	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Arsenic	0.0E+00	6.6E-06	8.7E-07	0.0E+00	0.0E+00	7.5E-06
Barium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium III	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Chromium VI	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cobalt	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Methylene Chloride	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Manganese	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Mercury (methyl)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nickel	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Selenium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Thallium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zinc	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cyanide	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benz[a]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[a]pyrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Benzo[b]fluoranthene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dibenz[ah]anthracene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Indeno[1,2,3-cd]pyrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pathway Total	0.0E+00	6.6E-06	8.7E-07	0.0E+00	0.0E+00	**7.5E-06**

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6.0 CONCLUSIONS

The following conclusions are based on the results of the Lake Erie and Grand River Baseline HRA presented in this report. These conclusions apply to site-wide issues, namely the human exposure pathways and risks associated with potential impacts of soils and groundwater at the Site to Lake Erie and the Grand River. Property-specific risk assessments will be submitted separately to address potential soil exposures and groundwater volatilization exposures at defined Operable Units (OUs) to support the feasibility studies based on reasonably anticipated land use at each OU. When taken together, this risk assessment for site-wide issues combined with the Operable Unit risk assessments will address all potential exposures and risks for the entire Site.

1. With respect to site-wide issues, complete and potentially significant pathways for human exposure to chemicals of interest associated with the Site are:

   - Potential releases from former and current industrial process areas and the former coke plant area, north of Fairport Nursery Road, through surface soil runoff and/or groundwater migration into Lake Erie, with subsequent exposures to chemicals in surface water, sediment and fish by persons using the Lake for recreational activities. Potential exposure pathways include dermal contact and incidental ingestion of surface water and sediment, and ingestion of fish caught near the shore adjacent to the Site.

   - Potential releases from former Solvay process residue settling basins, the former hydroretention basin, the chromium ore processing residue landfill, and the Painesville Township Landfill through surface soil runoff and/or groundwater migration and/or leachate into the Grand River, with subsequent exposures to chemicals in surface water, sediment and fish by persons using the River for recreational activities. Potential exposure pathways include dermal contact and incidental ingestion of surface water and sediment, and ingestion of fish caught in the River adjacent to the Site.

2. Potential releases of COIs from groundwater discharges to the Grand River and Lake Erie were evaluated using BIOSCREEN, a U.S. EPA groundwater fate and transport model (see Section 3.2.1). The predicted surface water concentrations at the point of discharge to surface water were compared to surface water quality standards for the protection of human health (non-drinking). This evaluation was performed to determine the potential for releases from the Site in groundwater to impact persons eating fish from the river and lake. All chemicals detected in groundwater at concentrations above their respective Outside Mixing Zone Average (OMZA) water quality standards were evaluated for their potential to migrate and discharge into Lake Erie and/or the Grand river, with assistance from Ohio EPA. The BIOSCREEN model was used to predict concentrations of COIs in groundwater at the point of discharge to surface water, assuming the maximum detected concentrations in each well migrate to the Lake and/or River by the

shortest groundwater flow path. Model predicted concentrations at the points of discharge were compared to OMZA surface water quality standards for the protection of human health (non-drinking). Model predicted concentrations at the point of discharge to Lake Erie exceed the OMZA surface water quality standards for the protection of human health for non-drinking water pathways for four chemicals (antimony, methylene chloride, carbon tetrachloride, and chloroform). Model predicted concentrations at the point of discharge to the Grand River exceed the OMZA surface water quality standards for four chemicals (antimony, chromium VI, mercury, and vinyl chloride).

3. COIs in Grand River surface water and sediment were included in a quantitative risk assessment for dermal and incidental ingestion exposures by recreators (see Sections 3.4.3, 3.4.4, 3.4.5 and 3.4.6). These estimated risks were added to estimated risks from the ingestion of chromium in tissues of fish caught from the river adjacent to the Site, even though detected concentrations of chromium in river water samples did not exceed the OMZA surface water quality criterion for the protection of humans for fish ingestion. The non-carcinogenic hazard index (HI) values presented in Table 17 show that the total HI for the Grand River Adult Recreator receptor population is 0.1 and the total HI for the Grand River Child Recreator receptor population is 0.5. The total estimated lifetime excess cancer risk posed to the Grand Adult Recreator receptor population is 4.3×10^{-6} and the total estimated lifetime excess cancer risk for the Grand River Child Recreator is 7.5×10^{-6}. (Table 18). Acceptable non-cancer hazards and acceptable excess lifetime cancer risks have been demonstrated for both Grand River receptor populations.

4. The Lake Erie sediment data indicates that eight chemicals detected in four Lake Erie sediment samples exceeded the USEPA Region IX residential soil PRGs. The exposure assumptions used to develop the PRGs are associated with human activities in residential soil, and these assumptions differ from those that may be associated with activities in sediment. Given the physical habitat constraints (steep cliff shoreline, rocks, debris, and hard clay bottom in some areas) and the depth at which sediment was collected, there is a low potential for the recreational user to come in contact with the sediment; a qualitative evaluation was therefore conducted. The metals are within the range of background concentrations in Lake Erie sediment (published by Painter et al., 1998), and Grand River sediment collected by Ohio EPA upstream of the Site. The PAHs may originate from several sources, including runoff from Fairport Harbor, and releases associated with the marina in addition to Study Area 2. If elevated PAH levels are detected in the event of further investigations in Study Area 2 during the feasibility study, additional evaluation will be conducted, as appropriate.

5. Based upon the results of this Lake Erie and Grand River Baseline HRA, it is concluded that the following chemicals detected in groundwater at the Site should be evaluated in the Feasibility Study (FS) because their model predicted concentrations exceed OMZA surface water quality standards for the protection of human health (non-drinking) at the point of discharge to either Lake Erie or the Grand River:

- **Grand River**
    - Antimony
    - Hexavalent chromium
    - Mercury
    - Vinyl chloride

- **Lake Erie**
  - Antimony
  - Carbon Tetrachloride
  - Chloroform
  - Methylene Chloride

5.0 RISK CHARACTERIZATION

The risk characterization provides a quantitative and qualitative discussion of the potential health hazards posed by the COIs in environmental media for each scenario. Both noncarcinogenic and carcinogenic health effects are addressed.

5.1 Noncarcinogenic Health Effects

Noncancer hazards are typically characterized using the "hazard quotient" approach (USEPA 1989a). The hazard quotient (HQ) is the ratio of the estimated chronic average daily dose (CADD) for a COI to the maximally acceptable "safe" dose for that chemical (*i.e.*, the USEPA-derived RfD). This is shown below, for an ingestion exposure:

$$\textit{Hazard Quotient} = CADD/RfD_{oral}$$

where

CADD	Chronic average daily dose (mg/kg-day); and
RfD_{oral}	Oral Reference Dose (mg/kg-day).

And for a dermal exposure:

$$\textit{Hazard Quotient} = CADAD/RfD_{dermal}$$

where

CADAD	Chronic average daily absorbed dose (mg/kg-day); and
RfD_{dermal}	Dermal Adjusted Reference Dose (mg/kg-day).

An HQ of unity (1) or less indicates that the chronic average daily dose for a particular COI is below the level associated with a toxic effects (USEPA, 1989a).

Chemical-specific CADD and CADAD values for each Grand River receptor population and environmental medium are presented in Tables 12 through 16 These CADD and CADAD values were used in conjunction with the USEPA RfDs (Section 4.2) as described above to calculate the HQ associated with exposure to the noncarcinogenic COIs. The resulting HQs were generated using the point estimate methodology and are also presented in Tables 12 through 16 (Grand River exposures). In summary, none of the chemical-specific, route-specific HQ values exceeded unity (1).

When there is potential exposure to more than one COI, additive noncarcinogenic health effects can be assessed by using the hazard index (HI) approach. The HI accounts for potential additivity of effects from COIs which affect a similar biological endpoint, or target organ. For this

Lake Erie and Grand River Baseline HRA, it was assumed that all COI effects are additive (*i.e.*, the HI approach was applied to assess the potential aggregate risks from *all COIs* within an exposure pathway), irrespective of the toxic endpoint, if any, of each COI. The simplified equation for calculating a generic pathway-specific HI is as follows:

$$\textit{Hazard Index} = HQ_1 + HQ_2 + \ldots + HQ_n$$

A hazard index (HI) of 1 or less indicates that levels of exposure to multiple COIs within one exposure pathway are acceptable.

Two types of hazard index are calculated in the risk characterization process. These include (1) a pathway-specific HI, which represents the aggregate risk from all chemicals of interest through one exposure pathway for one receptor population; and (2) a total HI, which represents the aggregate risk for all COIs across all exposure pathways for each receptor population. A comparison of the pathway-specific HI values allow the determination of which exposure pathway(s) present the greatest hazard, and which remedies may be most effective by mitigating hazards via one or more exposure pathways. The total HI is representative of the total dose received by an individual across all pathways and all COIs and provides an upper-bound value of the potential health risks posed to a receptor population associated with a given exposure scenario (*i.e.*, an intended land use) under consideration. As USEPA (1989a) guidance states:

> There are two steps required to determine whether risks or hazard indices for two or more pathways should be combined for a single exposed individual or group of individuals. The first is to identify reasonable exposure pathway combinations. The second is to examine whether it is likely that the same individuals would consistently face the "reasonable maximum exposure" (RME) for more than one pathway.

In this Lake Erie and Grand River Baseline HRA, all pathways evaluated for each receptor population scenario were summed to derive a total Hazard Index. Therefore, the Lake Erie and Grand River Baseline HRA assumed that individuals could consistently be exposed under RME conditions for all pathways of exposure. The pathway-specific HI values and total HI values for each Grand River receptor population are presented in Table 17.

The HI values presented in Table 17 show that the total HI for the Grand River Adult Recreator receptor population is 0.1, which is substantially below the target HI value of unity (1). About 39% of the total hazard posed to the Grand River Adult Recreator receptor population is attributable to the sediment ingestion pathway and principally through the chemicals of interest of arsenic, thallium, antimony, aluminum, manganese, and cyanide. About 32% of the total hazard posed to the Grand River Adult Recreator receptor population is attributable to the dermal contact with surface water pathway and principally through the chemicals of interest of hexavalent chromium and trivalent chromium.

The total HI for the Grand River Child Recreator receptor population is 0.5, which is substantially below the target HI value of unity (1). About 68% of the total hazard posed to the Grand River Child Recreator receptor population is attributable to the sediment ingestion pathway, principally through the chemicals of interest arsenic, thallium, manganese, antimony, aluminum and cyanide.

5.2 Carcinogenic Health Risks

Carcinogenic health risks are defined in terms of the probability of an individual developing cancer over a lifetime as the result of exposure to a given chemical at a given concentration (USEPA, 1989a). The incremental probability of developing cancer over a lifetime (*i.e.*, the theoretical excess lifetime cancer risk) is the additional risk above and beyond the cancer risk an individual would face in the absence of the exposures characterized in this risk assessment. The theoretical excess lifetime cancer risk is based on the LADD and is calculated as follows:

where:

$$ExcessLifetimeCancerRisk = LADD * SForal$$

LADD	Lifetime average daily dose (mg/kg-day)
SF	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$

and for dermal exposures:

$$ExcessLifetimeCancerRisk = LADAD * SFdermal$$

where:

LADAD	Lifetime average daily dose (mg/kg-day)
SF	Dermal Adjusted Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$

Chemical-specific LADD and LADAD values for each Grand River receptor population and environmental medium in Tables 12 through 16. These LADD and LADAD values were used in conjunction with the USEPA cancer slope factors (Section 4.2) as described above to calculate the estimated excess lifetime increase in cancer risk associated with exposure to the carcinogenic COIs. The resulting estimated excess lifetime cancer risks were generated using the point estimate methodology and are summarized for each scenario below. Consistent with the risk goal for the Ohio EPA as described in Paragraph (C)(1)(a) of Rule 3745-300-09 of the Ohio Administrative Code, an excess lifetime cancer risk of 1×10^{-5} represents an acceptable risk level. None of the chemical-specific excess lifetime cancer risks in Tables 12 through 16 (Grand River exposures) show an exceedance of the acceptable cancer risk goal.

Consistent with Ohio EPA (1996) and U.S.EPA (1989a) guidance, the excess lifetime cancer risks were considered to evaluate aggregate cancer risk posed to each receptor population. First, the chemical-specific excess lifetime cancer risks were summed among all carcinogenic chemicals of interest within an exposure pathway to calculate the pathway-specific cancer risk posed by each exposure pathway to each receptor population. Second, the pathway-specific excess lifetime cancer risks were summed to calculate the total excess lifetime cancer risk attributable to chemicals of interest to each receptor population. There are limitations to this approach of summation of cancer risks, as U.S.EPA guidance (1989a) states:

> There are several limitations to this approach that must be acknowledged. First, because each slope factor is an upper 95th percentile estimate of potency, and because upper 95th percentiles of probability distributions are not strictly additive, the total cancer risk estimate might become artificially more conservative as risks from a number of different carcinogens are summed. If one or two carcinogens drive the risk, however, the problem is not of concern.

And, as discussed previously with respect to summing hazard indices, USEPA (1989a) guidance states:

> There are two steps required to determine whether risks or hazard indices for two or more pathways should be combined for a single exposed individual or group of individuals. The first is to identify reasonable exposure pathway combinations. The second is to examine whether it is likely that the <u>same</u> individuals would <u>consistently</u> face the "reasonable maximum exposure" (RME) for more than one pathway.

In this Baseline Lake Erie and Grand River HRA, estimated chemical-specific lifetime cancer risks among all chemicals of interest within each exposure pathway were summed with the pathway-specific excess lifetime cancer risks for all exposure pathways evaluated for each receptor population. This approach is protective of the "RME" individual, given the limited toxicity data and lack of knowledge on contaminant interactions (i.e. whether they are synergistic or antagonistic).

The total estimated lifetime cancer risk posed to the Grand River Adult Recreator receptor population is 4.3 x 10^{-6} as presented in Table 18. About 66% of this estimated risk is posed by the sediment ingestion pathway, most notably arsenic which is the only carcinogen evaluated in the pathway. Dermal contact with sediment, again evaluated only for arsenic, contributes about one-third of the estimated cancer risk for the Grand River Adult Recreator receptor population. The total estimated lifetime cancer risk for the Grand River Child Recreator is 7.5 x 10^{-6}. Arsenic in sediments poses the risk by the ingestion (89% of total risk) and dermal contact (12%) pathways. Acceptable excess lifetime cancer risks have been demonstrated for both receptor populations.

5.3 Qualitative Uncertainty Analysis

There are multiple sources of uncertainty that may be identified for any risk characterization. The purpose of this section is to identify and discuss the uncertainties associated with the quantitative risk estimates presented in this assessment. This discussion serves to place the risk estimates in this assessment into proper perspective by discussing the assumptions and uncertainties inherent in the assessment (USEPA, 1989a), particularly the key variables and assumptions that contribute most to the uncertainty.

There are numerous sources of uncertainty inherent in the risk assessment process. Some level of uncertainty is introduced into the assessment each time an assumption is made. Many assumptions have valid and strong scientific bases while others are estimates usually represented by a range of values. Where there is uncertainty regarding an assumption, a conservative estimate is often chosen to ensure that the assessment will be health-protective. The following presents a consideration of the uncertainties associated with the risk assessment according to each of the major components of the assessment (*i.e.*, hazard identification, exposure assessment, toxicity assessment, and risk characterization).

5.3.1 Hazard Identification

Use of Nondetect Data – As recommended by USEPA guidance (1989a), nondetected concentrations of chemicals in environmental media were included in the calculation of the 95%

UCL concentrations using one-half the sample quantitation limit (USEPA, 1989a). It should be noted that in most cases a chemical present in media at a concentration equal to half the sample quantitation limit would be detected at least qualitatively (i.e., occur at a concentration *below* the sample quantitation limit but *above* the method detection limit or instrument detection limit). In this circumstance, the concentration of the chemical may be estimated, receiving a "J" qualifier from the laboratory. For this reason, the use of one-half the sample quantitation limit for a nondetect datum is conservative since, if the COI was present at a concentration of one-half of its sample quantitation limit, it would most likely be above the instrument detection limit. Thus, the sample concentration would likely be reported by the laboratory as a "qualified" data point. In extreme cases, this practice can skew the lower bound of the distribution such that the UCL concentration may exceed the maximum concentration detected. Thus, for all data with a detection frequency of less than 50%, the maximum reported concentration was used.

Determination of Representative Medium-Specific Concentrations - For this Lake Erie and Grand River Baseline HRA, the 95% UCL or maximum measured concentration of each COI was used as the exposure point concentration (EPC). Environmental data are generally log-normally distributed and the average concentration, therefore, is best described by the geometric mean (USEPA, 1992c). However, the 95% UCL represents an upper bound value for the arithmetic mean (*i.e.*, 95 percent of estimated mean values from a sampling data set will be less than the 95% UCL). This approach was used for the RME evaluations to (1) reduce any uncertainty associated with mean values, because a 95% UCL may not be representative for small sampler sizes (n<8) and (2) to maintain consistency with Ohio EPA guidelines for risk assessments (OEPA, 1996).

As mentioned above, chemicals that were detected with less than 50% frequency were evaluated using the maximum concentration (USEPA 1989b). This method most likely overestimates actual exposure.

5.3.2 Exposure Assessment

Exposure Parameters - Most parameters incorporated into the exposure assessment are highly conservative values to define upper-bound RME population exposures. Some of the well-established RME exposure factor values are utilized in this Lake Erie and Grand River Baseline HRA, albeit for recreational use receptor populations not defined in Ohio EPA or USEPA risk assessment guidance. These exposure factors include soil ingestion rates, exposure duration, skin surface area expose and soil-to-skin adherence factor. Other exposure factor parameters were Site-specific, including exposure frequency, sediment ingestion rate, sediment-to-skin adherence factor and fish ingestion rate. The Site-specific exposure factor values were intended to represent upper-bound, RME-type values, and thus represent a conservative estimate of exposure in the absence of detailed information about the recreational exposures at the Site.

Uncertainty is associated with the determination of exposure point concentration, most significantly with respect to the prediction of surface water concentrations from ground water data. The prediction of surface water concentrations in both the Grand River and Lake Erie are conservative estimates. The predictions assume that all groundwater entering the river and lake contains COIs at the maximum detected groundwater concentrations; furthermore, attenuation during transport within the subsurface between monitoring wells and the river and lake is not taken into account. The predicted surface water concentrations therefore represent a reasonable maximum estimate of ground water impacts to surface water. The predictions that groundwater discharges of antimony, methylene chloride, carbon tetrachloride, and chloroform may exceed their respective human health non-drinking water quality standards in the Lake and the predictions that groundwater discharges of antimony, chromium VI, mercury, and vinyl chloride may exceed their respective human health non-drinking water quality standards in the Grand River must be interpreted with respect to the conservatism implicit in the modeling assumptions.

Dieldrin in Groundwater – Dieldrin was identified as a COI for groundwater. Dieldrin was not evaluated quantitatively using the BIOSCREEN groundwater model. Rather, dieldrin is evaluated qualitatively here since 1) dieldrin's human health non-drinking water OMZA is 0.0000065 ug/L, far below achievable reporting limits, thus making it impossible to demonstrate compliance using modeling or direct measurement, 2) dieldrin is detected in groundwater at the Site at only four groundwater wells (out of 85 wells) and as "J" estimated values (i.e. below the Practical Quantitation Limit), 3) the Site does not have known past historical uses of dieldrin that would lead to potential sources or source areas on the Site and 4) on-site soils are not a source of dieldrin to groundwater.

Dieldrin is not found in soils on-Site at levels of concern to human health. Only one soil sample collected during the Phase I and Phase II RI sampling was detected above the USEPA Region

IX Residential Soil PRG for dieldrin. During Phase II RI sampling, soil sample MW-1B1-03 was collected within the covered area of Parcel 1B1, at a distance of 1,100 feet from Lake Erie, at a depth of 0-3 feet. Dieldrin was detected in this sample at a concentration of 0.27 mg/kg, above the residential soil PRG of 0.03 mg/kg. All other soil samples collected during the Phase I and II sampling were below the residential soil PRG.

5.3.3 Toxicity Assessment

Reference Doses – Toxicity information for many of the COIs is limited for humans. Consequently, depending on the quality and extent of toxicity information, varying degrees of uncertainty will be associated with the calculated toxicity values. The USEPA derives RfDs for chemicals using an uncertainty factor approach. For example, the RfD for bis(2-ethylhexyl)phthalate is derived on the basis of several uncertainty factors totaling 1,000, indicating the lack of confidence in the toxicity data upon which it is based. In contrast, the uncertainty factor for arsenic is only 3 indicating that there is a high degree of confidence in the data. In general, the procedures used to extrapolate from animals to humans in toxicity studies include a conservative use of uncertainty factors so that potential effects on humans are likely overestimated rather than underestimated. As discussed in Section 4.1, it is widely accepted in the scientific community that low doses of toxicants may be detoxified by any one of several processes present in human organ-systems (Ames *et al.*, 1987). As a result, humans may not react to the same degree as the population of genetically homogeneous laboratory animal populations used in standard bioassays.

Slope Factors - A cancer slope factor, by definition, is a "plausible upper-bound estimate of the probability" of developing cancer per unit dose over a lifetime. These estimates are conservative for two reasons: (1) they are based on a very conservative model for low-dose extrapolation (*i.e.*, linearized multistage model); and (2) the 95% upper confidence limit of the slope of the dose-response curve is used when the information is based on animal studies. In some cases, slope factors derived from human studies are based on the best estimate (*i.e.*, median) of the dose-response curve (USEPA, 1989a).

Weight-of-Evidence Classification - The USEPA classifies chemical carcinogens in terms of the quality and quantity of information that supports or refutes a chemical's carcinogenicity. The weight-of-evidence classification provides a qualitative index by which the USEPA and its external reviewers rank the confidence in the carcinogenic potency of the chemical.

5.3.4 Risk Characterization

Summation of Risks and Hazards Across Pathways - In this assessment, the potential for cancer risks and noncancer hazards were evaluated assuming additivity across exposure pathways and chemicals. This practice, although generally conservative, ignores possible synergisms or antagonisms with other chemicals which may be present in the environment and affect the absorption, metabolism (metabolic activation or detoxification), and ultimately the net toxicity of the COIs. Therefore, there is a significant amount of uncertainty associated with the assumption of additivity used in this assessment.

Section 5.2 of the Lake Erie and Grand River Baseline HRA stated that a considerable degree of uncertainty, and a likely overestimate of cancer risk, may result from the summation of risks from a number of single-chemical cancer risk estimates. However, since the risk estimates of only two carcinogens were considered cumulatively in this evaluation, any overestimate of cancer risk due to the summing of upper-bound estimates of incremental lifetime cancer risk is probably insubstantial.

5.3.5 Uncertainty Analysis Summary

The Lake Erie and Grand River Baseline HRA applied many conservative assumptions to ensure that the potential for current and future exposures is not underestimated. U.S. EPA guidance cautions that "because upper 95^{th} percentiles of probability distributions are not strictly additive, the total cancer risk estimate might become artificially more conservative as risks from a member of different carcinogens are summed." (U.S. EPA, 1989a). Thus, the estimates of excess lifetime cancer risk and noncancer hazard provided in Section 5.2 probably represent, on balance, an overestimate of the actual risks or hazards posed to the receptor populations of interest at the Site.

4.0 TOXICITY ASSESSMENT

The Toxicity Assessment section presents the USEPA verified toxicity criteria and dose-response data for the COIs. The dose-response curve characterizes the relationship between the dose of a chemical and the frequency of an adverse health effect in an exposed population (USEPA, 1989a). The dose is the quantity of the chemical that enters the body through all routes of exposure. The manner in which the dose-response relationship for a given chemical is quantitatively evaluated depends upon the nature of the adverse health effect. For example, the risks associated with very low doses of carcinogens are predicted using models; whereas, for noncarcinogenic effects, uncertainty factors are used to estimate a dose which is safe even for sensitive human subpopulations.

Most of the information concerning the dose-response relationship of chemicals is based on data collected from animal studies and theoretical precepts about what might occur in humans. The USEPA maintains an online database called the *Integrated Risk Information System* (IRIS) (USEPA, 2003) which provides toxicity values for chronic oral and inhalation exposures based upon these studies. All data contained in IRIS are verified by a USEPA work group, approved by each office of USEPA, and are updated routinely. In cases where IRIS does not provide toxicity data, the Health Effects Assessment Summary Tables (HEAST; USEPA, 1997b) were used as a secondary source. HEAST is a USEPA document that supplements IRIS by providing nonverified toxicity values, as well as values for evaluating the potential for noncancer effects following subchronic exposures. In cases where toxicity criteria for a chemical were not provided from either of the above sources, National Center for Environmental Assessment (NCEA) provisional values as obtained from USEPA Region IX and/or Region III Risk-Based Concentration Tables were used.

The dose-response relationship is often established under controlled conditions in order to minimize responses due to confounding variables. In the evaluation of carcinogenicity, mathematical models are typically used to extrapolate the relatively high doses administered to animals to predict potential human responses at environmental contaminant levels that are typically far below those tested in animals. Although carcinogens are typically assumed to exhibit no threshold dose, such low doses may be "detoxified" or rendered inactive by the myriad of protective mechanisms that are present in humans (Ames, 1987). Consequently, the results of standard animal bioassays at high doses are of limited use in accurately predicting a dose-response relationship in humans at environmentally relevant concentrations. However, in the absence of studies with sufficient high numbers of subjects to detect carcinogenicity at environmentally relevant doses, cancer potency criteria based on high doses are relied upon.

4.1 Chronic Noncarcinogenic Health Effects

In experimental systems such as animal bioassays, a threshold limit is approximated by the dose at which no adverse effects are observed. It is widely accepted that most biological effects of chemicals occur only after a threshold dose is exceeded (Klaassen *et al.*, 1996; Paustenbach, 1989a). For the purposes of establishing noncarcinogenic health criteria, this threshold dose is usually estimated from the no-observed-adverse-effect-level (NOAEL) or lowest-observed-adverse-effect-level (LOAEL) determined in chronic or subchronic animal or human studies. The NOAEL is defined as the highest dose at which no adverse effects appear, while the LOAEL is the lowest dose at which adverse effects begin to appear (Klaassen *et al.*, 1996). The LOAEL or NOAEL from the most sensitive animal or human study is used by the USEPA to establish long-term health criteria, termed reference doses (RfDs). The RfD is a daily uptake level (mg/kg-day) for the human population, including sensitive subpopulations, that is not expected to cause adverse health effects over a lifetime of exposure (USEPA, 1989a).

In an attempt to account for limitations in the quality or quantity of available toxicity data, uncertainty factors are used with NOAELs (or LOAELs) to set RfDs for noncarcinogenic effects. Generally, an experimental NOAEL is divided by an uncertainty factor ranging from 1 to 10,000. An uncertainty factor of three or ten (representing one-half or one order of magnitude) are often applied to the NOAEL to account for each of the following uncertainties, as appropriate: inter-species differences between the test animal and the human population of interest; differences in sensitivity within the human population, thus accounting for a sensitive subpopulation; differences between exposure period of the study (*i.e.*, subchronic) and the exposure duration of interest in the human population (*i.e.*, chronic); and differences between a LOAEL and a NOAEL from any study where the LOAEL was used as the critical dose in *lieu* of a NOAEL. Additionally, a modifying factor of from 1-10 may be applied to account for any additional uncertainties attributable to study design or data quality. RfDs are thus generally very conservative (*i.e.*, health protective) due to the use of large uncertainty (safety) factors.

Route-specific non-cancer toxicity criteria are used to evaluate oral and inhalation exposures (RfDs and RfCs, respectively). In the absence of verified inhalation RfCs for the COIs which are volatile organic compounds, values from USEPA Region IX preliminary remediation goal tables were used, or in their absence, toxicity criteria from USEPA Region III Risk-Based Concentration tables. If a verified inhalation RfC were not available for a COI which was not a volatile organic compound, then the inhalation pathway was not evaluated for that chemical.

Toxicity values are seldom available for the dermal pathway. In accordance with USEPA (1989a) and Ohio EPA (1996) guidance, in the absence of such information, the dermal pathway was addressed by adjusting the oral RfD using a chemical-specific oral absorption factor (OAF). A fundamental difference must be recognized when deriving dermal toxicity values from oral toxicity values: oral and inhalation RfDs are generally expressed in terms of an *administered* dose, whereas the calculated dermal RfDs are expressed in terms of an *absorbed* dose. This adjustment is accomplished by multiplying an administered dose oral RfD by an OAF. OAFs are utilized when available from chemical-specific toxicity profiles prepared by the Agency for Toxic Substances and Disease Registry (ASTDR), or from other sources, as appropriate. In the absence of chemical-specific oral absorption data, an OAF of 1 is assumed (*i.e.*, 100% of the chemical is gastrointestinally absorbed).

4.2 Carcinogenic Health Effects

The accepted regulatory approach generally assumes that carcinogenic chemicals should be treated as if they have no threshold of activity (Paustenbach, 1989a). In other words, it is assumed that any dose of a carcinogen, no matter how small, is assumed to present a cancer risk. To estimate theoretically plausible responses at low doses, various mathematical models which describe the expected quantitative relationship between risk and dose can be used (Paustenbach, 1989a,b). While most models may fit the dose-response relationship adequately at high exposure levels used in animal studies, their ability to accurately predict responses at low doses may vary significantly (Paustenbach, 1989b). The accuracy of the projected risk depends on how well the model predicts the true relationship between dose and risk at dose levels where the relationship cannot actually be measured.

The mathematical model currently used by the USEPA for low-dose extrapolation is the linearized multistage model (LMS). This model is based on the multistage theory of the carcinogenic process, which attempts to account for the fact that, in many types of cancer, the logarithm of the cancer mortality rate increases in direct proportion to the logarithm of age. This suggests that a cell may go through a sequence of specific changes (stages) before reaching a malignant state. The LMS model is used in USEPA carcinogen assessments to estimate the dose-response characteristics of carcinogens at low exposure levels typically encountered in the environment. Health risks for exposures to carcinogens are defined in terms of probabilities. These probabilities identify the likelihood of a carcinogenic response in an individual that receives a given dose of a particular compound. The slope factor (SF), expressed in units of $(mg/kg\text{-}day)^{-1}$, multiplied by the daily human dose of the chemical expressed in mg/kg-day, provides an estimate of the theoretical cancer risk.

The USEPA classifies compounds, according to their weight-of-evidence (WOE) for carcinogenicity into the following six groups (USEPA, 1989a):

Group A	Human Carcinogen (sufficient evidence of carcinogenicity in humans)
Group BI	Probable Human Carcinogen (limited evidence of carcinogenicity in humans)
Group B2	Probable Human Carcinogen (sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
Group C	Possible Human Carcinogen (limited evidence of carcinogenicity in animals or lack of human data)
Group D	Not Classifiable as to Human Carcinogenicity (Inadequate or no evidence)
Group E	Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

For the COIs evaluated in this Lake Erie and Grand River Baseline HRA, only arsenic and Cr (VI) (inhalation pathway only) are classified as Group A carcinogens (USEPA, 1998a). Chromium (III) has not been assigned a Weight of Evidence ranking.

Route-specific toxicity criteria for the evaluation of carcinogenicity are used to evaluate oral and inhalation exposures (Slope Factors and Air Unit Risk Factors, respectively). As mentioned earlier, toxicity values are seldom available for the dermal pathway. In accordance with USEPA (1997a) and Ohio EPA (1996) guidance, to account for the difference between absorbed and administered dose, the dermal pathway was addressed by adjusting an administered dose oral SF using a chemical-specific OAF. For an administered dose oral SF, this adjustment was accomplished by dividing the oral SF by the OAF.

The chemical-specific toxicity criteria used in this Lake Erie and Grand River Baseline HRA are summarized in Table 10.

3.0 EXPOSURE ASSESSMENT

This section presents the Site Conceptual Model and identifies the complete exposure pathways and potentially exposed populations. Exposure potential is evaluated, including fate and transport modeling for releases from groundwater to surface water. Exposure factor assumptions, such as contact rate and duration, are presented. The Chronic Average Daily Dose (CADD) or Chronic Average Daily Absorbed Dose (CADAD) for non-carcinogens, and the Lifetime Average Daily Dose (LADD) or Lifetime Average Daily Absorbed Dose (LADAD) for carcinogens are calculated and presented in this section.

3.1 Site Conceptual Model For Human Health Risk Assessment

The Lake Erie and Grand River Baseline HRA focuses on those exposure pathways which involve the exposures of receptor populations to Site-related chemicals in the Grand River and Lake Erie, and the discharges from the Site to those surface water bodies. The concentrations of Site-related chemicals in the Grand River and Lake Erie may be impacted by releases of contaminants from multiple Study Areas. The fate and transport of those contaminants in the mobile media (groundwater, surface water) are associated with multiple Study Areas, as well as possible releases from off-Site sources at up-gradient and upstream locations.

Two site conceptual models (SCMs), illustrating the exposure pathways that are evaluated in this Lake Erie and Grand River Baseline HRA, are presented: Figure 3 depicts potentially complete exposure pathways from the Site to Lake Erie, and Figure 4 depicts potentially complete exposure pathways from the Site to the Grand River. Exposure refers to contact between the subject and the environmental media (*e.g.*, air, water, soil) containing the COI. Chemical agents cannot exert deleterious effects unless they come in contact with the organism and reach the site of biological action. The primary elements that determine the degree of toxicity, as it relates to exposure, are the routes of administration (*e.g.*, breathing, eating, or touching), and the duration of exposure.

In order for exposure to occur, a complete exposure pathway must be present. Exposure pathways are the means by which the chemical in an environmental medium may be delivered to an individual. The pathways are largely determined by factors such as site activities, including present and future land-uses; proximity of populations to the affected media; the physico-chemical properties of the agent; and the physical attributes of the site setting. There are four factors necessary to constitute a complete exposure pathway (USEPA, 1989a). These are:

- A source and mechanism of chemical release into the environment;
- A transport medium (such as air, water, dust) that can move the chemical from the source to the receptor;
- A point of contact with the affected transport medium; and
- A means of taking the chemical into the body (exposure route) such as breathing vapors or dust, ingestion or dermal contact with the affected medium.

These four criteria were considered when evaluating the potential for exposure to the affected media at the Site.

With respect to site-wide issues, as shown in Figures 3 and 4 complete and potentially significant pathways for human exposure to chemicals of interest associated with the Site are:

- Potential releases from former and current industrial process areas, the former coke plant area, and the area surrounding and including the one acre landfill, north of Fairport Nursery Road, through surface soil runoff and/or groundwater migration into Lake Erie, with subsequent exposures to chemicals in surface water, sediment and fish by persons using the Lake for recreational activities. Potential exposure pathways include dermal contact and incidental ingestion of surface water and sediment, and ingestion of fish caught near the shore adjacent to the Site.
- Potential releases from former Solvay process residue settling basins, the former hydroretention basin, the chromium ore processing residue landfill, and the Painesville Township landfill through surface soil runoff and/or groundwater migration and/or leaching into the Grand River, with subsequent exposures to chemicals in surface water, sediment and fish by persons using the River for recreational activities. Potential exposure pathways include dermal contact and incidental ingestion of surface water and sediment, and ingestion of fish caught in the River adjacent to the Site.

Potential discharges to the Grand River and Lake Erie through surface soil runoff at the Site is not addressed in this Lake Erie and Grand River Baseline HRA. These discharges will be evaluated in the Property-specific risk assessments that will be submitted separately to address exposures at defined OUs as part of feasibility studies based on planned property development and use at each OU. Any complete exposure pathway resulting from surface soil runoff to surface water may require further evaluation and the implementation of a remedy to control runoff. The most effective remedies for controlling runoff from surface soils to surface water include capping, grading and stormwater management. These remedies are most appropriately evaluated with respect to the planned redevelopment options for each OU.

As shown in the SCMs, human exposures at the Grand River were determined to include:

Exposures to river water and sediment, and fish ingestion, by adults and children who fish from and wade in the Grand River.

Human exposures at Lake Erie were determined to include:

- Exposures to lake water and sediment, and fish ingestion, by adults and children who fish from and wade in Lake Erie.

As the Grand River is used for recreational fishing, it is appropriate to evaluate potential human health impacts that may occur during fishing activities (ingestion and dermal contact with sediments and fish ingestion). Based upon discussions with Ohio EPA, both adult and child exposures were addressed for the fish ingestion pathway. It is also appropriate to evaluate potential exposures to adults and children that may occur during recreational activities (ingestion and dermal contact with sediments, and ingestion and dermal contact with surface water). In general, both current and future reasonable anticipated land uses are factored into the risk assessment. As discussed above, recreational opportunities for surface water contact such as fishing, canoeing, swimming, and wading currently exist in the Grand River Study Area. The anticipated future redevelopment (ranging from residential to commercial) may result in enhanced recreational opportunities in the Grand River and surface water contact opportunities may therefore be enhanced.

3.2 Comparisons To Health-Based Standards For Surface Water

Ground water underlying the Site may discharge to surface water bodies adjacent to the Site. These surface water bodies include Lake Erie, located to the north of the Site; and the Grand River, which roughly bisects the southern two-thirds of the Site. A network of groundwater monitoring wells has been located throughout the Site in accordance with the Phase II RI Workplan. Fairport Nursery Road, which transects the northern half of the Site on an east-west axis, has been identified as the approximate divide between the groundwater flows which impact Lake Erie (north of Fairport Nursery Road) and the Grand River (south of Fairport

Nursery Road). Ground water underlying most of Study Area 1 and all of Study Areas 2 and 3 may release chemicals of interest from the Site into Lake Erie. Additionally, groundwater underlying a portion of Study Area 1 and all of Study Areas 4, 5, 6 and 7 may release chemicals of interest from the Site into the Grand River.

These releases from Site groundwater into the Grand River and Lake Erie can result in exposures to Site-related COIs by persons using the river or lake for recreational purposes, as described in the previous section. Several ways of evaluating this exposure potential were used in the Lake Erie and Grand River Baseline HRA, as follows.

1. As described in Section 2.3.5, surface water and groundwater data were compared to surface water quality criteria for the protection of humans (non-drinking). The human health drinking water criteria do not apply to the Grand River or Lake Erie since there is not a surface water intake for a public water supply system within 500 yards of the Site, in accordance with Paragraph (B)(3) of Rule 3745-1-07 of the OAC. Wherever maximum detected concentrations are below the non-drinking criteria (OMZA), the COI can be assumed to be of acceptable risk by the fish consumption pathway. The human heath water quality criteria for non-drinking water evaluate the exposures to human receptor populations through the ingestion of fish tissue from fish populations representative of trophic levels three and four in the aquatic ecosystem. These trophic levels are inclusive of the sport fish of interest in the Grand River and Lake Erie, including smallmouth bass, largemouth bass, white bass, channel catfish, steelhead trout, and walleye, and less-desirable fish such as common carp and rock bass.

2. Any chemical of interest in the Grand River which exceeded the human health criterion for non-drinking water was further evaluated for the fish ingestion exposure pathway in the risk assessment (see Section 3.4.6). Ingestion of fish from the Grand River is not quantitatively evaluated using fish tissue data because of the difficulty associated with determining the relationship, if any, between Site activities and the presence of any constituents in fish tissue. Thus, the Phase II RI Work Plan did not provide for the sampling of Grand River or Lake Erie fish for fish tissue samples. However, any COI which exceeds a human health surface water standard for non-drinking water (i.e., fish ingestion) was evaluated on the basis of predicted fish tissue concentrations, calculated from surface water concentrations and bio-concentration factors (BCFs).

3. All COIs in Grand River surface water and sediment were included in a quantitative risk assessment for dermal and incidental ingestion exposures by recreators (see Sections3.4.3, 3.4.4, 3.4.5, and 3.4.6). Additionally, total chromium, hexavalent chromium, and filtered hexavalent chromium did not exceed the human health criterion for non-drinking water and were also evaluated for incidental ingestion of, and dermal contact with, surface water. These chemicals were quantified in addition to the COIs since the screening criterion (*i.e.*, the human health criterion for non-drinking water) did not

specifically address direct contact exposures to surface water by adults and children engaged in recreational activities. COIs in Lake Erie sediment were evaluated in a quantitative risk assessment in Section 3.4.1.

The quantitative risk assessment using the surface water data as described in Item #3 above represents an estimate of current potential risk to human receptor populations. Potential future releases of COIs from the Site by groundwater migration to the Grand River and Lake Erie were evaluated using a fate and transport groundwater model (see Section 3.2.1 below). The predicted surface water concentrations at the point of discharge were then compared to surface water quality standards for the protection of human health (non-drinking). This evaluation was performed to determine the potential for releases from the Site in groundwater to impact aquatic species in, and persons wading in and eating fish from, the river and lake.

3.2.1 BIOSCREEN Modeling of Groundwater Migrating to the Grand River and Lake Erie

U.S. EPA's BIOSCREEN model version 4.1 (July, 1997) was used to evaluate chemicals in groundwater migrating to the Grand River. A groundwater chemical of interest (COI) list was developed in cooperation with Ohio EPA and consists of groundwater chemicals exceeding OMZA criteria at the groundwater well locations. Groundwater COIs are as follows:

- Arochlor –1254 and Arochlor –1260
- Arsenic
- Barium
- Benzene
- Benzo(a)pyrene
- Carbon Tetrachloride
- Chloroform
- Chromium VI
- Cyanide
- 4-4'-DDT
- Dieldrin
- Mercury
- Naphthalene
- Pentachlorophenol
- Phenanthrene
- Vanadium
- Vinyl Chloride

Dieldrin was evaluated separately from the quantitative BIOSCREEN model since 1) dieldrin's human health non-drinking water OMZA is 0.0000065 ug/L, far below achievable reporting limits, thus making it impossible to demonstrate compliance using modeling or direct measurement, 2) dieldrin is detected at only four groundwater wells (out of 85 wells) and as "J" estimated values (i.e., below the Practical Quantitation Limit), 3) the Site does not have known past historical uses of dieldrin that would lead to potential sources or source areas on the Site and 4)) on-site soils are not a source of dieldrin to groundwater. Dieldrin is discussed qualitatively in the uncertainty section (Section 5.3.2).

Each maximum detected groundwater concentration in each groundwater well with an OMZA exceedance for that COI was modeled using the distance from that well to either the Grand River or Lake Erie (depending upon the groundwater divide) or to both the Grand River and Lake Erie for the 33 wells identified as being within the "groundwater divide zone" as determined by OEPA. Groundwater from the following 33 wells, located north of Fairport Nursery Rd. within the "groundwater divide zone" were modeled to both Lake Erie and the Grand River:

- SW1-2
- SW1-1
- SW1-3
- P1B1-01
- SW1-7
- MW-1B1-08
- MW-1B1-06
- MW-1B1-05
- MW1B1-04
- MW-1B1-03
- MW-1B1-02
- SW1-4
- ASR-MW8
- ASR-MW1
- ASR-MW2
- ASR-MW5
- CL1-1/MW-7
- ASR-MW3
- MWB-1
- MWB-5
- ASR-MW4
- SW1-5
- SW1-10
- SW3-4
- SW1-8
- MW-40
- MW-49
- MWB-2
- MW-47
- MWB-6
- SW1-12

- MWB-4
- SW1-6

The BIOSCREEN model inputs and assumptions were discussed and agreed upon with OEPA at a meeting held on March 19, 2003. The hydrogeology, dispersion, adsorption, biodegradation, general inputs, and source area input assumptions are summarized in Table 1 of Attachment E. Inputs and assumptions specific to each chemical and monitoring well location are summarized in Table 2 of Attachment E. Model predicted groundwater concentrations at the point of discharge to either Lake Erie or the Grand River or both (e.g. depending upon the groundwater divide zone) are compared to OMZA water quality criteria in Tables 3-18 of Attachment E.

Model predicted concentrations at the point of discharge to Lake Erie exceed the OMZA surface water quality standards for the protection of human health (non-drinking) for three chemicals (carbon tetrachloride, chloroform, and vinyl chloride). Model predicted concentrations at the point of discharge to the Grand River exceed the OMZA surface water quality standards for the protection of human health (non-drinking) for three chemicals (chromium VI, mercury and vinyl chloride).

Based on these results, Ohio EPA requested in a letter dated April 16, 2003 that either 1) the remainder of the metals and chlorinated solvents, (not yet modeled), be modeled to determine the complete list of metals and chlorinated solvents to be evaluated further or 2) conclude that all metals and chlorinated solvents require further evaluation. Based on Ohio EPA's recommendations, the remainder of the metals and chlorinated solvents exceeding OMZA standards within the groundwater wells were modeled. These results are presented in Tables 19-30 of Attachment E and summarized below:

Model predicted concentrations at the point of discharge to Lake Erie exceed the OMZA surface water quality standards for the following additional metals and additional chlorinated solvents: antimony, methylene chloride, and 1,2-dichloroethane. Model predicted concentrations at the point of discharge to the Grand River exceed the OMZA surface water quality standards for the following additional metals and additional chlorinated solvents: antimony only. A summary of the chemicals with BIOSCREEN model predicted concentrations at the point of discharge exceeding OMZA surface water quality standards by Study Area is provided below. :

A conference call to discuss Ohio EPA's April 16, 2003 BIOSCREEN comments was held on April 17, 2003. During the April 17, 2003 conference call, Uniroyal representatives raised concerns regarding the modeling results for the chlorinated solvents originating from the Uniroyal parcel(s). They maintain that for a certain area of the site the BIOSCREEN model was an over-simplified 1-step model that uses a uniform hydraulic gradient from the origin wells to Lake Erie (much lower elevation), which may result in overestimation of predicted concentrations at the point of discharge to Lake Erie. Based on the outcome of this call, the chlorinated solvents were modeled using the 2-step model for the groundwater pathway to the Lake (i.e. to divide the model runs for the pathway to the Lake into two parts 1) the "flat gradient area" near the source wells and 2) "the steep gradient area" near the Lake shoreline) for the chlorinated solvents. The results of the 2-step BIOSCREEN model of the chlorinated solvents in groundwater migrating toward Lake Erie are presented in Tables 32- 37 of Attachment E and are summarized below:

Model predicted concentrations at the point of discharge to Lake Erie exceed the OMZA surface water quality standards for the protection of human health from non-drinking water pathways using the 2-Step BIOSCREEN model for the following chlorinated solvents: carbon tetrachloride, chloroform, and methylene chloride. The 2-step model eliminated 1,1-dichloroethane, 1,2-dichloroethane and vinyl chloride for pathway to the Lake from further consideration as chemicals with predicted concentrations exceeding OMZAs at the point of discharge.

Study Area	Parcel ID	Model Predicted Concentrations Exceed OMZA at the Point of Discharge to Lake Erie	Model Predicted Concentrations Exceed OMZA at the Point of Discharge to Grand River
Study Area #1			
Antimony	1B2	X (Aq. Life & HH)	
Carbon Tetrachloride	1B3	X (Aq. Life & HH)	
Chloroform	1B3	X (Aq. Life & HH)	
Cobalt	1B1	X (Aq. Life only)	
Methylene Chloride	1B3	X (Aq. Life & HH)	
Selenium	1B2	X (Aq. Life only)	
Silver	3B1	X (Aq. Life only)	
Vinyl Chloride	1C5		X (HH only)
Study Area #2			
Cyanide	2C1	X (Aq. Life only)	
Study Area #3			

Study Area #4			
Cyanide	4B2		X (Aq. Life only)
Study Area #5			
Cyanide	5B1		X (Aq. Life only)
Study Area #6			
Antimony	6B1		X (Aq. Life & HH)
Arsenic	6B1		X (Aq. Life only)
Copper	6B1		X (Aq. Life only)
Cyanide	6B1		X (Aq. Life only)
Chromium VI	6B1		X (Aq. Life & HH)
Selenium	6B1		X (Aq. Life only)
Vanadium	6B1		X (Aq. Life only)
Vinyl Chloride	6B1		X (HH only)
Study Area #7			
Barium	7C1/7B1		X (Aq. Life only)
Mercury	7B1 and 7C1		X (HH & Wildlife)

HH = OMZA for the protection of human health via non-drinking water (i.e. fish ingestion).

Aq. Life = OMZA for the protection of aquatic life.

Wildlife = OMZA for the protection of wildlife

Groundwater chemicals with model predicted concentrations that exceed OMZA surface water quality standards at the point of discharge to either Lake Erie or the Grand River may pose a potential risk to human health via non-drinking water pathways and will be evaluated further in the Feasibility Study (FS) portion of the project.

3.2.2 Painesville Township Landfill Leachate

The Painesville Township Landfill is located on Parcel 7B1 and is currently capped and covered with grass. The landfill ceased operations over 20 years ago. Slopes along the river are steep and covered with four to six feet tall vegetation. At the toe of the landfill along the river are areas of thick reeds and some small trees. The landfill operated as a municipal solid and industrial waste landfill during the 1960s and 1970s. Ohio EPA sampled Painesville Township landfill leachate on March 20, 1996 and analyzed for; BOD, COD, ammonia, filterable residue, total cyanide, nitrate, organochlorine pesticides and PCBs, metals, mercury, VOCs and SVOCs. The analytical data are included in Attachment C. All analytes were below appropriate water quality standards with the exception of dissolved solids. Dissolved solids were detected at both sample locations PTL-1 (3,483 mg/L) and PTL-2 (2,518 mg/L) above the Outside the Mixing Zone Average (OMZA) water quality standard for aquatic life of 1,500 mg/L. An OMZA water quality standard is not available for the protection of human health non-drinking water. However, both sample locations also exceed the range of OMZA water quality standards for the protection of drinking water (500-750 mg/L). Historical seeps from the Painesville Township Landfill may have been and continue to be contributing to TDS loadings to the Grand River.

3.3 Exposure Point Concentrations

Reliable estimates of exposure point concentrations are required to calculate the magnitude of exposure to the potentially exposed populations. For the soil, groundwater, sediments, and surface water, COI concentrations were measured directly to derive exposure point concentrations. An exposure point concentration (EPC) for each COI in each medium is developed for the risk assessment. If the detection frequency for a data set was less than 50%, the maximum concentration was used as the EPC (USEPA, 1989a). For all data sets with a detection frequency greater than 50%, a 95% upper confidence limit (UCL) of the arithmetic mean concentration was calculated according to the distribution of the data. Per current USEPA (1992c) guidance, the chemical data for the COIs in each media were tested to determine if they had a normal, lognormal, or undefined distribution using the D'Agostino (1990) test. The EPC for those data that had a normal distribution was the 95% UCL of the arithmetic mean for a normal distribution (USEPA, 1992c). For those data that had a lognormal or undefined distribution, the EPC was the 95% UCL of the arithmetic mean for a lognormal distribution (USEPA, 1992c). The D'Agostino test was not performed on data sets with fewer than 8 samples. For those data sets, the 95% UCL of the arithmetic mean for a lognormal distribution was used (USEPA, 1992c). If the calculated 95% UCL for any data set exceeded the maximum detected concentration, the maximum was used as the EPC.

For those COIs for which the surface water exposure point concentration exceeded the human health water quality standard for non-drinking water, EPCs in fish tissue were based upon maximum surface water concentrations multiplied by a bio-concentration factor (BCF) from the USEPA. This calculation is explained in detail in Section 3.4.6 below.

Table 7 presents the EPCs for the COIs in Grand River sediments. Table 8 presents the EPCs for the COIs in Lake Erie sediment. Table 9 presents the EPCs for the COIs in Grand River surface water. The medium-specific exposure point concentrations are summarized for each COI in Table 10.

3.4 Calculation of Dose

For the above defined exposure scenarios, dose was quantified according to standard Ohio EPA and USEPA calculation algorithms (OEPA, 1996; USEPA, 1989a). The exposure parameters used for each pathway analysis are presented, as is the basis for their selection and use. Consistent with the Workplan (SECOR, 1997), the Lifetime Average Daily Doses (LADDS) for potential carcinogenic effects and Chronic Average Daily Doses (CADDs) for potential noncarcinogenic effects were calculated based upon the potentially complete exposure scenarios as described above. The exposure factors used to calculate intake (*i.e.*, dose) were those recommended by the Ohio EPA and are based on information available in the scientific literature. For those scenarios for which very little data exist such as the number of days per year when trespassing activities may occur, discussions with Ohio EPA and best professional judgment were used. If Site use changes in the future such that the exposure assumptions used below are no longer protective or appropriate, the risk assessment for the individual Operable Units will be revised to reflect this.

3.4.1 Lake Erie Exposures

Lake Erie bottom sediments were collected off the shore of Lake Erie near Study Areas 1 and 2 during the Phase I RI. Sediment cores were attempted to be collected at a distance of approximately 30 feet off shore of Lake Erie, where the water depth is approximately five feet, per the RI/FS Work Plan. Two attempts were made to collect sediment samples as specified. However, due to the large number of rocks, boulders, and other debris present approximately 30 feet from the shore, it was impossible to collect sediment samples at location SD3-1, located offshore of Study Area 3. A third attempt to collect the sediment samples using a SCUBA diver was successful, and resulted in collection of the four sediment cores approximately 100 feet off-shore. The fifth planned sediment sample SD3-1, was not collected because the lake bottom east of SD2-2 (offshore of Study Area 3) consisted of hard clay and was covered with rocks. Sediment sampling equipment would not penetrate the clay material. The sediment samples shown on Figure 2, were collected to a depth of two feet below the sediment surface.

The steep cliff shoreline,rocks, debris and in some areas hard clay bottom, result in low potential for current receptors to come in contact with contaminated Lake-bottom sediments. However, since anticipated future development may result in better access to the Lake, a qualitative evaluation of the potential risks from contact with sediment by the Lake Erie recreational receptor population was conducted.

The chemicals detected in the Lake Erie sediment core samples are presented in Table 2. Table 5 presents a comparison of the Lake Erie sediment data to the Region IX USEPA Residential PRGs. A total of eight chemicals (three metals; arsenic, manganese and thallium and five PAHs; benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected above the USEPA Region IX residential soil PRGs. The exposure assumptions used to develop the PRGs are associated with human activities in residential soil, and these assumptions differ from those that may be associated with activities in Lake Erie sediment. Additionally, the USEPA Region IX PRGs are screening values based on a risk goal of 1×10^{-6}, and an HI of 0.1, an order of magnitude below the risk goal of 1×10^{-5} and HI of 1 for the Site. The concentrations of arsenic, manganese and thallium are below or within the range of background concentrations identified from 69 Lake Erie sediment samples taken in 1997 and 1998 as published by Painter et al. in 2001. The concentrations of these three metals are also within the range of mean and upperbound background concentrations identified for Grand River sediments collected by Ohio EPA upstream of the Site from RM5.5 – RM8.5. PAHs detected in Lake Erie sediment may originate from several sources. There are ongoing sources such as storm runoff from streets and parking lots in Fairport Harbor and possible releases associated with the marina. In addition, Study Area 2 is a former Coke Plant. If further investigations are conducted in Study Area 2 during the Feasibility Study (FS), and elevated levels of PAHs are detected in proximity to Lake Erie, additional evaluation may be necessary.

3.4.2 Exposure via Incidental Sediment Ingestion – Grand River

The potential exists for each potentially exposed population to ingest incidental amounts of impacted sediments from the Grand River. The dose associated with this exposure pathway was quantified according to the following equations:

$$CADD = \frac{Csed * IRsed * CF * EF * ED}{BW * ATn}$$

where:

CADD	Chronic average daily dose for noncarcinogens (mg/kg-day);
Csed	Concentration of chemical in sediment (mg/kg);
IRsed	Ingestion rate for sediment (mg/day);
CF	Conversion factor (10^{-6} kg/mg);
EF	Exposure frequency (days/year);

ED	Exposure duration (years);
BW	Body weight (kg); and
ATn	Averaging time for non-carcinogens (days).

and

$$LADD = \frac{Csed * IRsed * CF * EF * ED}{BW * ATc}$$

where:

LADD	Lifetime average daily dose for potential carcinogens (mg/kg-day);
Csed	Concentration of chemical in sediment (mg/kg);
IRsed	Ingestion rate for sediment (mg/day);
CF	Conversion factor (10^{-6} kg/mg);
EF	Exposure frequency (days/year);
ED	Exposure duration (years);
BW	Body weight (kg); and
ATc	Averaging time for carcinogens (days).

The exposure factors used to derive the estimated doses are summarized in Table 11 and are discussed below.

Concentration in sediment

The exposure point concentration for each COI in Grand River sediment will be either the maximum concentration, or the 95% upper confidence limit of the arithmetic mean concentration, from a data set of directly measured concentrations.

Sediment Ingestion

For the purposes of this Lake Erie and Grand River Baseline HRA, incidental sediment ingestion was conservatively considered to be analogous to soil ingestion. The soil ingestion rates provided in the Ohio EPA Voluntary Action Program (VAP; OEPA, 2002) were used in this Lake Erie and Grand River Baseline HRA. The sediment ingestion rates are 200 mg/day for children under the age of six (*i.e.*, the Grand River Child Recreator), and 100 mg/day for individuals older than six years (*i.e.*, the Grand River Adult Recreator).

Exposure Frequency

Ohio EPA used best professional judgment to develop a Site-specific upper bound exposure frequency of 90 days/year for surface water recreational activities in the Grand River. This EF of 90 days/year is based on exposures occurring 4 days/week during the 15 warmer weeks of the year (Memorial Day through Labor Day) and 2 days/week during the 15 weeks of spring and fall (i.e. no exposures from October through February). Ohio EPA comments and discussions confirm that an EF of 90 days/year will be protective of the future RME receptors (including adolescents) residing in the proximity of the Grand River.

Exposure Duration

The exposure duration for the sediment ingestion pathway for the Grand River Adult Recreator is the Ohio EPA VAP default value of 24 years for residential adult. The exposure duration for the sediment ingestion pathway for the Grand River Child Recreator is the Ohio EPA VAP default value of 6 years for residential child. These values were used so that the child and adult exposures equal 30 years (OEPA, 1996). This approach is more conservative than assuming 30 years of exposure as an adult because the dose for a child is expected to be higher than for an adult.

Body Weight

The standard Ohio EPA default values for body weight of 70 kg for an adult and 15 kg for a child were used for the Grand River Adult Recreator and Grand River Child Recreator receptor populations, respectively (OEPA, 2002).

Averaging Time

The standard averaging time of 25,550 days (70 years) was used for the cancer LADD calculations (OEPA, 2002) for both the Grand River Adult Recreator and Grand River Child Recreator receptor populations. The averaging time for the non-cancer CADD calculations is equal to the exposure duration times 365 days/year. Therefore, the averaging times for the Grand River Child Recreator is 2,190 days (six years), and that for the Grand River Adult Recreator is 8,760 days (24 years).

3.4.3 Exposure via Dermal Contact with Sediment – Grand River

Potential exposure via dermal contact with sediment was determined according to the following equations:

$$CADAD = \frac{Csed * AF * ABS * SA * CF * EF * ED}{BW * ATn}$$

where:

CADAD	Chronic average daily absorbed dose for noncarcinogens (mg/kg-day);
Csed	Concentration of chemical in sediment (mg/kg);
AF	Soil adherence factor (mg/cm^2);
ABS	Dermal absorption factor (unitless fraction);
SA	Skin surface area (cm^2/day);
CF	Conversion factor (10^{-6} kg/mg);
EF	Exposure frequency (days/year);
ED	Exposure duration (years);
BW	Body weight (kg); and
ATn	Averaging time (days).

and

$$LADAD = \frac{Csed * AF * ABS * SA * CF * EF * ED}{BW * ATc}$$

where:

LADAD	Lifetime average daily absorbed dose for potential carcinogens (mg/kg-day);
Csed	Concentration of chemical in sediment (mg/kg);
AF	Soil adherence factor (mg/cm^2);
ABS	Dermal absorption factor (unitless fraction);
SA	Skin surface area exposed (cm^2/day);
CF	Conversion factor (10^{-6} kg/mg);
EF	Exposure frequency (days/year);
ED	Exposure duration. (years);
BW	Body weight (kg); and
ATc	Averaging time (days).

The exposure factors used to calculate CADADs and LADADs via dermal contact with sediment are described below with the exception of those parameters that were also used to quantify uptake through ingestion, which were described in Section 3.4.3. All exposure factors used to derive the estimated doses are summarized in Table 11.

Soil-to-Skin Adherence Factors and Exposed Skin Surface Skin

Soil-to-skin adherence factors were determined by agreement with Ohio EPA, using information contained in the *Exposure Factors Handbook* (USEPA, 1997). This information was based largely on the soil-to-skin adherence data published by John Kissel of the University of

Washington (Kissel *et al.*, 1996), and best professional judgment with respect to the value appropriate for each exposure scenario. A soil-to-skin adherence factor of 0.3 mg/cm^2 was used for both the Grand River Adult Recreator and Grand River Child Recreator receptor populations.

The values for skin surface area exposed were 5,700 cm^2 for the Grand River Adult Recreator and 2,900 cm^2 for the Grand River Child Recreator .

Dermal Absorption Factor

Dermal absorption fraction (ABS) is used to determine the amount of a chemical that is absorbed through the skin from soil. ABS terms have been experimentally determined for only a few chemicals (USEPA, 1992b). Chemical-specific dermal absorption factors include those for arsenic (0.03), cadmium (0.001), DDT (0.03), polycyclic aromatic hydrocarbons (0.13 and pentachlorophenol (0.25). In the absence of experimental data, ABS values of 0.1 for SVOCs and 0.01 for metals were used per Ohio EPA guidance (OEPA, 1996).

3.4.4 Incidental Ingestion of Surface Water – Grand River

$$CADD = \frac{Csw * IRsw * EF * ED}{BW * ATn}$$

where:

CADD	Chronic average daily dose for noncarcinogens (mg/kg-day);
Csw	Concentration of chemical in surface water (mg/liter);
IRsw	Ingestion rate for surface water (liters/event);
EF	Exposure frequency (events/year);
ED	Exposure duration (years);
BW	Body weight (kg); and
ATn	Averaging time for noncarcinogens (days).

and

$$LADD = \frac{Csw * IRsw * EF * ED}{BW * ATc}$$

where:

LADD	Lifetime average daily dose for potential carcinogens (mg/kg-day);
Csw	Concentration of chemical in soil (mg/liter);
IRsw	Ingestion rate for surface water (liters/event);
EF	Exposure frequency (events/year);

ED	Exposure duration (years);
BW	Body weight (kg); and
ATc	Averaging time for carcinogens (days).

The exposure factors used to derive the estimated doses are summarized in Table 11 and are discussed below.

Concentration in surface water

The exposure point concentration for each COI in surface water will be either the maximum concentration, or the 95% upper confidence limit of the arithmetic mean concentration, from a data set of directly measured surface water concentrations.

Ingestion Rate of Surface Water

The value of 0.050 liters/event is the value recommended by USEPA in Exhibit 6-12 *of Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A* (1989). This value was used for both the Grand River Adult Recreator and Grand River Child Recreator receptor populations.

3.4.5 Dermal Contact with Surface Water – Grand River

Potential exposure via dermal contact with surface water was determined according to the following equations:

$$CADAD = \frac{Csw * SA * PC * ET * EF * ED * CF}{BW * ATn}$$

where:

CADAD	Chronic average daily absorbed dose for noncarcinogens (mg/kg-day);
Csw	Concentration of chemical in surface water (mg/liter);
SA	Skin surface area exposed (cm^2);
PC	Permeability constant (cm/hour);
ET	Exposure Time (hours/event);
EF	Exposure frequency (events/year);
ED	Exposure duration (years);
CF	Conversion factor (10^{-6} kg/mg);.
BW	Body weight (kg); and
ATn	Averaging time for noncarcinogens (days).

and

$$LADAD = \frac{Csw * SA * PC * ET * EF * ED * CF}{BW * ATc}$$

where:

LADAD	Lifetime average daily absorbed dose for carcinogens (mg/kg-day);
Csw	Concentration of chemical in surface water (mg/liter);
SA	Skin surface area exposed (cm^2);
PC	Permeability constant (cm/hour);
ET	Exposure Time (hours/event);
EF	Exposure frequency (events/year);
ED	Exposure duration (years);
CF	Conversion factor (10^{-6} kg/mg);
BW	Body weight (kg); and
ATc	Averaging time for carcinogens (days).

The exposure factors used to calculate CADADs and LADADs via dermal contact with surface water are described below with the exception of those parameters that were also used to quantify uptake through ingestion, which were described in Section 3.4.5. All exposure factors used to derive the estimated doses are summarized in Table 11.

Exposure Time

Ohio EPA used best professional judgment to develop a Site-specific exposure time of two hours/event to be protective of not only current recreational receptors, but also future residential populations. The ET of two hours/event for surface water recreational activities was used to evaluate surface water dermal contact for the Adult and Child Recreator receptor populations.

Permeability Constant

The values for permeability constant are chemical-specific for organic chemicals, based on the values found in Table 5-8 of USEPA's Dermal Exposure Assessment (1992b); the default value for inorganic chemicals is 1×10^{-3} cm/hour, based on Ohio EPA guidance (2002).

3.4.6 Exposure via Fish Ingestion – Grand River

The dose associated with fish ingestion was quantified according to the following equation:

$$CADD = \frac{Cfish * IRfish * CF * EF * ED}{BW * AT}$$

where:

CADD	Chronic average daily dose for noncarcinogens (mg/kg-day);
Cfish	Concentration of chemical in fish tissue (mg/kg);
IRfish	Ingestion rate for fish (mg/day);
CF	Conversion factor (10^{-6} kg/mg);
EF	Exposure frequency (days/year);
ED	Exposure duration (years);
BW	Body weight (kg); and
ATn	Averaging time for non-carcinogens (days).

and

$$LADD = \frac{CS * IF * CF * EF * ED}{BW * AT}$$

where:

LADD	Lifetime average daily dose for potential carcinogens) (mg/kg-day);
Cfish	Concentration of chemical in fish tissue (mg/kg);
IRfish	Ingestion rate for fish (mg/day);
CF	Conversion factor (10^{-6} kg/mg);
EF	Exposure frequency (days/year);
ED	Exposure duration (years);BW Body weight (kg); and
ATc	Averaging time for carcinogens (days).

The exposure factors used to derive the estimated doses are summarized in Table 11 and are discussed below.

<u>Concentration in fish tissue</u>

Fish tissue concentrations for this evaluation are not based upon directly measured fish tissue data. Instead, the exposure point concentration is modeled for any for any Grand River surface water COI which exceeds the human health standard for non-drinking water (none of the COIs exceed), as well as for total chromium, which is the principal COI in surface water from the Site. The modeled fish tissue concentration (mg/kg) is determined by multiplying the surface water concentration (mg/liter) by a bio-concentration factor (BCF) (liter/kg).

Chromium concentrations in the surface water (0.22 mg/l) met the human health non-drinking water quality standard of 14 mg/l. Although chromium is not a COI for surface water, Ohio EPA has expressed special concerns regarding the migration of chromium from the groundwater underlying Study Area 6 to the Grand River. Thus, chromium concentration in fish tissues was predicted by the use of a BCF of 19, as cited in *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, (USEPA, 1999). The BCF for total chromium is the only value for chromium provided in the reference; hexavalent chromium is not expected to exist in the reducing conditions nearly universal in animal tissues (Barnhart, 1997). The predicted fish tissue concentration for chromium is thus calculated as:

$$0.22 \text{ mg/L} \times 19 \text{ L/kg} = 4.18 \text{ mg/kg chromium in fish tissue.}$$

Fish Ingestion Rate

An adult fish ingestion rate of 32,000 milligrams/day was used based upon the recommendation of Ohio EPA (1998). This ingestion rate is equivalent to 52 fish meals a year of ½ pound (227 grams) each from the Grand River, averaged over 365 days/year. This also represents the 50th percentile value for a recreational fisherman based upon the data presented in *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory* (Great Lakes Sport Fish Advisory Task Force, 1993). This fish ingestion rate is more than twice the total fish ingestion rate of 15,000 mg/day used by the State of Ohio in the calculation of the human health water quality criteria (OAC 3745-1-38(C)(3), effective October 31, 1997). The fish ingestion rate of 15,000 mg/day used in the calculation of Ohio human health surface water quality standards represents the sum of ingestion rates of 3,600 mg/day and 11,400 mg/day of trophic level three and trophic level four fish, respectively. A higher fish ingestion rate was selected for this Lake Erie and Grand River Baseline HRA to account for the planned improvements in access to the Grand River at the Site and the popularity of the Site as a recreational fishing spot.

The State of Ohio Water Quality Criteria consider fish ingestion intakes for adults, but not children, in the development of standards for human health based on non-drinking water exposures (i.e., fish ingestion). Few data are available concerning dietary fish intakes of young children, and their fish consumption is likely to be much less than that of persons six years of age or older. Nonetheless, children ages 1-5 years are evaluated for fish ingestion in this Lake Erie and Grand River Baseline HRA using U.S. EPA's Exposure Factors Handbook recommended ingestion rate of 5.63 g/day, which includes all recreational fish (freshwater, estuarine or marine). Future development plans include residences in proximity to the Grand River and will facilitate river access by residents and recreational fishers, thus encouraging fishing adjacent to the Site.

Exposure Frequency

An exposure frequency of 365 days/years was utilized to agree with the fish ingestion rate, averaged over 365 days/year.,

3.4.7 Chronic Average Daily Doses and Lifetime Average Daily Doses

Chemical-specific values for CADD, CADAD, LADD and LADAD for the each exposure pathway are presented in Tables 12 through 16. Each calculated intake was determined based on the information presented above. Chemical-specific hazard values are determined by comparison of the CADD and CADAD with the chemical-specific Oral Reference Dose and adjusted Dermal Reference Dose, respectively. Chemical-specific excess lifetime cancer risk values are determined by multiplying the LADD and LADAD by the Oral Slope Factor and adjusted Dermal Slope Factor, respectively. The derivation of the toxicity criteria for this evaluation (*i.e.*, the Oral Reference Dose, the adjusted Dermal Reference Dose, the Oral Slope Factor, and the adjusted Dermal Slope Factor) are presented and discussed in Section 4.0 of this Lake Erie and Grand River Baseline HRA, Toxicity Assessment. The results of these calculations are presented and discussed in Section 5.0 - Risk Characterization.

2.0 HAZARD IDENTIFICATION

The primary purpose of this hazard identification is to evaluate chemical concentrations detected in all media associated with the Site and identify COIs with respect to potential human exposure and health risk. The Lake Erie and Grand River Baseline HRA incorporates data collected during both the Phase I RI and Phase II RI as well as valid historical data collected after 1985. Section 2.1 provides a brief overview of the site history and current site setting, while Section 2.2 describes the chemical data sets that are considered in this analysis. Section 2.3 presents the COI selection methodology and results.

2.1 Site History

The former Diamond Shamrock Chemical Company's (DSCC) Painesville Works Site is located in Lake County, Ohio, and is situated on approximately 1,130 acres of land. The site is bordered on the north by Lake Erie, on the south by Elm Street, on the west by SR 535 and East Street and on the east by industrial property and the Grand River. The site is located in the corporate limits of Painesville Township, Painesville, and The Village of Fairport Harbor.

The site has been subdivided into seven distinct Study Areas based on activities conducted in each area during plant operations. . A brief history and description of each Study Area is provided below. A more detailed description may be found in the *Remedial Investigation/Feasibility Study Work Plan for the Diamond Shamrock Painesville Works Site* (SECOR, 1997).

Study Area 1 was the primary location for the historical manufacture of soda ash from limestone using the Solvay process. Other chemical manufacturing processes conducted in this area include the manufacture of chlorine and caustic soda (using diaphragm cells), hydrochloric acid, carbon tetrachloride, Chlorowax (chlorinated paraffin wax), purified calcium products (mainly limestone fines, chalk, *etc.*), sodium bicarbonate, sodium sulfate, aluminum hydroxide, liquid hydrogen, and cement. Other products manufactured include polyvinyl chloride, vinyl chloride monomer, ammonium hydroxide, aluminum smelting, and various commercial and light industrial operations. In addition, steam and electricity were generated on site using coal-fired boilers. Uniroyal (a.k.a.Crompton Manufacturing) operated a PVC facility from 1950 through 1975 and a vinyl chloride monomer facility from 1950 through 1961, on 12.4 acres of Study Area 1. This parcel was also formerly used by Martin Marietta and Uniroyal Chemical Company, Inc.

to manufacture vinyl chloride monomer and polyvinyl chloride. Aluminum Smelting and Refining Company, Inc. (ASR) owns a metal smelting operation on 23.4 acres of Study Area 1. This parcel is now operated by Philip Metals (the current lease holder) and was the former Diamond Shamrock Portland Cement Plant. Adjacent to the ASR site is land owned and operated by PVS Chemicals. This site was used to store waste acid from steel manufacturers. Norfolk and Western Railway Company has operated a roundhouse maintenance yard and rail spurs in Study Area 1 since 1936.

In 1986, buildings that housed soda ash, carbon tetrachloride, and electricity production were demolished, and a clay cover was placed over Study Area 1, consisting of a 6 in. to > 2 ft. thick layer of natural clay material excavated from nearby fly-ash disposal pits. The clay layer was topped with soil, and the area was re-vegetated. Current activities at Study Area 1 involve light industrial and commercial operation. Of the 166 acres in Study Area 1, 46% is industrial, 33% is maintained (the clay-cover area), 20% is old field, and the remaining 1% is mixed old field and shrub-scrub.

Study Area 2 is currently owned by Ace Lakefront Properties. Coal coking operations were conducted at this location from 1924 to 1976 by Diamond Shamrock Chemicals Company and from 1976 to 1982 by Erie Coke and Chemical Company (now known as Scepter Management Corporation). Ace Lakefront Properties has partially demolished the abandoned coal coking plant. Study Area 2 is approximately 41 acres in size and contains approximately 76% old field and 24% industrial land cover.

Study Area 3 is owned, and to be maintained for perpetuity, by Tierra Solutions Incorporated. The study area includes a hazardous waste landfill (the One-Acre Landfill) and surrounding property. The One-Acre Landfill accepted laboratory materials from Diamond Shamrock research operations until its closure in 1989. The landfill's multimedia cap includes a high-density polyethylene liner, a 36-inch clay layer, an 18-inch topsoil layer, and vegetation (SECOR, 1997). The landfill is surrounded by a 36-inch slurry-wall. Study Area 3 is approximately 27.76 acres in size and consists primarily of old field land cover (93%), with the remainder consisting of the maintained landfill cap (7%).

Study Area 4 was formerly used as a settling basin for the treatment of Solvay process residues (essentially limestone fines and chlorides suspended in water) from soda-ash manufacturing operations at Study Area 1 (SECOR, 1997). The basin also received waste pickle liquor (hydrochloric acid used to clean steel surfaces) and fly ash and bottom ash from coal-fired power generation facilities (operated by Cleveland Electric Illuminating Company and Diamond Shamrock). Environmental Brine Services, Inc. formerly operated an oil field waste injection well and storage tanks on 15 acres of land along the northwest portion of Study Area 4. The southern portion of Study Area 4 contains a 15 acre former municipal landfill for the Village of Fairport Harbor, which operated from the 1950s to the late 1980s. A 7 acre area in the southwest corner of Study Area 4 was formerly owned by Diamond Alkali and now consists of baseball fields owned by the Fairport Board of Education. Several commercial and light-industry businesses are located along the eastern and northern edges of the study area. The 178 total acres in Study Area 4 consists of approximately 27% old field, 27% mixed old field and shrub-scrub, 12% shrub-scrub, 8% mixed shrub-scrub and forested land covers, 2% forest, 3% bare ground (dirt bike trails) with trees, 9% maintained (former landfill), 4% recreational, and 8% industrial areas.

Study Area 5, the former "Hydroretention Basin," consists of land formerly used as a secondary settling basin for Solvay process residues from soda-ash manufacturing operations at Study Area 1. The basin also received 70 to 90 million gallons of non-contact cooling water per day from the Solvay process facilities and the power plant (SECOR, 1997), relatively low volumes of wastes from other processes, and debris from the demolition of buildings in Study Area 1. A minimum of two feet of clean clay was placed over the entirety of the former settling basin contained in Study Area 5 during the 1980s. Upon placement of the clay cover, a vegetative cover was established over the entire surface area of Study Area 5 to control erosion. Study Area 5 is approximately 29 acres in size, of which 79% is old field and 21% is shrub-scrub.

Study Area 6, the former "Settling Basin #2," accepted Solvay process residues generated from soda-ash manufacturing operations at Study Area 1. The study area also contains chromite ore processing residue (COPR) from chromium product operations that occupied the eastern portion of the study area (SECOR, 1997). On July 14, 1983, the U.S. EPA enacted an Administrative Order of Consent (United States District Court of the Northern District of Ohio, Civil Action No. C80-1857) for Study Area 6. Closure activities occurred between 1974 and 1983. Closure involved covering 90 acres of land with a minimum of 36 inches of fly ash, 36 inches of clay, topsoil, and vegetation. The entire study area is approximately 149 acres. As part of the Administrative Order of Consent, groundwater and the Grand River adjacent to Study Area 6 have been monitored since 1983.

Study Area 7, the former "Settling Basin #4," served as a settling basin for Solvay process residues from the soda-ash manufacturing processes at Study Area 1. The basin also received waste pickle liquor and treated effluent from the chromium plant. Electrode Corporation generated acid wastes containing titanium, and it is reported that those wastes were disposed in the settling basins of Study Area 7. The Painesville Township Commissioners formerly operated a municipal landfill in the western part of this Study Area. Another land owner (Joe Berrick, Nacelle Land and Management Corporation and Propane Supply) operated a brine disposal well with two small brine-receiving ponds in this area. Study Area 7 is approximately 520 acres in size. Approximately 60% of Study Area 7 is old field and is vegetated primarily with common reed (*Phragmites australis*). The remaining land is 21% shrub-scrub, 7% mixed old field and shrub-scrub, 7% forested, and 5% maintained.

For purposes of this Lake Erie and Grand River Baseline HRA, it is useful to view the Site according to:

- Study Areas 1, 2, and 3 - which border Lake Erie and have groundwater flow toward the lake; and
- Study Areas 1, 4, 5, 6, and 7 - which have groundwater flow toward the Grand River.

Figure 1 provides a plan view of the site and identifies the present site boundary and the seven Study Areas. A brief description of the portions of the Grand River and Lake Erie adjacent to the Site are provided as follows.

The Grand River, located in the Erie-Ontario Lake Plain ecoregion of Ohio, flows from east to west through the Site, forming a border for Study Areas 4, 5, 6, and 7 (OEPA, 1995). The Grand River flows into Lake Erie in Fairport Harbor, west of the Site. For the Lake Erie and Grand River Baseline HRA, the Grand River study area adjacent to the Site is defined as including river miles (RM) 5.4 to 2.8. The Ohio EPA designates the Grand River as Exceptional Warmwater Habitat upstream of RM 5.5 and Warmwater Habitat downstream of RM 5.5 (OEPA, 1995; Ohio Administrative Code 3745-1-10, effective March 29, 2001). Downstream of RM 4.7, the river is classified as a Lake Erie estuary and harbor area, based on interim Ohio EPA guidance (OEPA, 1995), and has since been classified as a lacustuary zone.

About 7000 feet of the Lake Erie shoreline forms the northern boundary of Study Areas 1, 2, and 3. An approximately 1000-foot shoreline protection system protects the One-Acre Landfill in Study Area 3 (SECOR, 1997). Lake Erie is designated by the Ohio EPA as Exceptional Warmwater Habitat, a superior high quality water, a public water supply, an agricultural water supply, an industrial water supply and as bathing waters (Ohio Administrative Code 3745-1-31, effective March 29, 2001).

2.2 Chemical Characterization

This section summarizes the data used to identify COIs and evaluate human health risks. In order to ensure that all data used in the Lake Erie and Grand River Baseline HRA are comparable to the data collected during the Phase I and Phase II RI and are representative of current conditions at the site, only data collected after 1985 were used in this risk assessment. Most of the site-related data collected before 1985 are surface water (Grand River) samples. The results of these analyses are now 17 or more years old, and thus may no longer be representative of the current conditions at the Site. Data used in this risk assessment, although not formally checked for quality assurance and quality control (QA/QC) by Ohio EPA, are valid and have been appropriately qualified.

2.2.1 Surface and Subsurface Soil

The surface and subsurface soil data sets are not formally evaluated in the Lake Erie and Grand River Baseline HRA.

Surface soils and subsurface soils will be quantitatively evaluated in the separate risk assessments to be developed for the individual Study Areas or the operable units therein. Surface and subsurface soils were used in the Lake Erie and Grand River Baseline HRA to evaluate potential sources of COIs to the groundwater, Lake Erie and Grand River.

Phase II Remedial Investigation Report for the Painesville Works Site. (SECOR, 2001).
This data set contains both surface (0-4') and subsurface (>4') soil concentration data for Study Areas 1, 2, 3, 4, 5, 6, and 7 (SECOR, 2001). The Parcels within these Study Areas were each tested for different analytes due to various factors discovered in the Phase I RI.

Phase I Remedial Investigation Report for the Diamond Shamrock Painesville Works Site. (SECOR, 1999)
This data set contains both surface (0'-2') and subsurface (>2') soil concentration data for the Study Areas 1, 2, 3, 4, 5, and 7. Samples collected for this study were analyzed for Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals including hexavalent chromium [Cr(VI)].

Screening Level Investigation Report. (ENSR, 1995).
This data set contains surface soil concentration data for Study Areas 1, 4, 5, and 7. Different chemical analyses were conducted based on the Study Area from which the sample was collected. Samples from Study Area 1 were analyzed for aluminum and PCBs. Samples from Study Area 4 were analyzed for arsenic and calcium. Samples from Study Area 5 were analyzed for aluminum and arsenic. Samples from Study Area 7 were analyzed for calcium, total chromium, and Cr(VI).

Lake County Water Intake Investigation. (Lake County, 1995).
This data set contains subsurface soil samples collected in Study Area 1. These samples were analyzed for VOCs, SVOCs, and metals.

James Paul Management, Inc. (James Paul Management, 1995).
This data set contains subsurface soil samples collected from the Uniroyal (formerly Dartron) Site located in Study Area 1. These samples were analyzed for VOCs, SVOCs, and metals.

Uniroyal Investigation at the Dartron Site. (Uniroyal, 1993).
This data set contains subsurface soil samples collected from the Uniroyal (formerly Dartron) Site located in Study Area 1. These samples were analyzed for VOCs, total petroleum hydrocarbons (TPH), and mercury.

Human Health Risk Assessment for the Fairport Harbor School District Baseball Fields. (CLH, 1993).
This data set contains surface soil samples collected from the baseball fields located in Study Area 4. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

Dartron Investigation at the Dartron Site. (Dartron, 1991).
This data set contains subsurface soil samples collected from the Dartron Site located in Study Area 1. These samples were analyzed for VOCs, total PCBs (instead of Aroclor mixtures), TPH, and metals.

USEPA Screening Site Inspection Report for Painesville Plant. (USEPA, 1990a).
This report contains surface soil samples for Study Areas 4, 5, and 7 and two subsurface soil samples collected from Study Areas 5 and 7. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

Site Assessment, Little Seedlings, The Painesville Works Site. (CLH, 1988).
This data set contains surface soil samples that were collected from Study Area 4. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

2.2.2 Groundwater

The groundwater data collected during the Phase I RI and Phase II RI were used in this analysis (SECOR, 1999; SECOR 2002). For the Phase I RI, one round of groundwater samples was collected from monitoring wells located in Study Areas 1, 2, 3, 4, 5, and 7. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. For the Phase II RI, two rounds of samples were collected from monitoring wells located in Study Areas 1, 2, 3, 4, 5, 6, and 7. Each sample within these Parcels was analyzed for different parameters based upon information obtained from the Phase I RI groundwater sampling.

2.2.3 Sediment

The following data sets were used to characterize chemical concentrations in surface sediments from Lake Erie and the Grand River within the boundaries of the Site:

Phase I Remedial Investigation Report for the Diamond Shamrock Painesville Works Site. (SECOR, 1998).
Four surface sediment samples were collected near the Lake Erie shore of Study Areas 1, 2, and 3. These surface sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals including Cr(VI).

Phase II Remedial Investigation Work Plan for the Painesville Works Site. (SECOR, 2000).
During this investigation, two sediment samples were collected in the Grand River. The sample with the highest fraction organic carbon content was analyzed for vinyl chloride. Vinyl chloride was not detected in this sediment sample. This vinyl chloride result was not included in the risk evaluation for this Site since the sample was not collected using the sampling protocol specified under the approved RI Work Plan.

Biological and Sediment Quality Study of the Grand River in the Vicinity of the Diamond Shamrock Waste Lagoons Area. (OEPA, 1995).
This data set consists of surface sediment (0-0.5') samples collected from river miles 2.8 to 5.4 in the Grand River within the boundaries of the Site. These sediment samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals including Cr(VI).

USEPA Expanded Site Inspection Memorandum. (USEPA, 1991c).
This data set contains surface sediment (0-0.5') samples that were collected from the Grand River within the boundaries of the Site. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

2.2.4 Surface Water

Surface water samples collected from the Grand River from 1985 to 2001 were used in this Lake Erie and Grand River Baseline HRA. Surface water samples were not collected from Lake Erie in the Phase I RI or Phase II RI, and surface water samples have not been historically collected from Lake Erie near the Site boundaries owing to the uncertainties associated with such surface water analyticals. Therefore, surface water COIs for Lake Erie are not identified in this Lake Erie and Grand River Baseline HRA. The Grand River surface water data sets used in this risk assessment are as follows:

Biological and Water Quality Study of the Grand River – Lake, Ashtabula, and Geauga Counties. (OEPA, 1987).
Two surface water samples were collected during this study in 1987 from the Grand River within the boundaries of the Site. These two samples (O-GR-2.8 and O-GR-3.1) were analyzed for metals and a list of water quality parameters (*e.g.*, nitrates, nitrites, *etc.*) that is broader than the target analyte list specified for surface water in the RI. Several hundred samples collected under the ACO and during the RI are being used to characterize target analytes in the Grand River. The results from these two surface water samples were not incorporated into the Baseline Human Health Risk Assessment because they were collected prior to the approval of the RI Work Plan and no quality control information was available. The two samples had no detected concentrations of total chromium and their TDS results have been incorporated into the ecological risk assessment.

Analytical Data Collected from Sampling of Monitoring Wells in the Painesville Works Site and the Grand River under a USEPA Administrative Order of Consent. (CLH, 1997).
This data set includes surface water samples that were collected from locations within the boundaries of the site from 1985 to 1996. These samples were analyzed for total chromium and Cr(VI).

United States Geological Survey (USGS) Surface Water Sampling from 535 Bridge. (USGS, 1997). This data set contains surface water samples from the USGS sampling location for the Grand River at the 535 Bridge that were collected from 1985 to 1994. These samples were analyzed for metals and water quality parameters.

A Second Study of Hexavalent Chromium in the Grand River, Ohio. (White, 1989).
This data set contains surface water samples collected in 1988 from the Grand River. These samples were analyzed for Cr(VI).

Phase II Remedial Investigation Work Plan for the Painesville Works Site. (SECOR, 2000).
This data set contains fifteen surface water samples collected from 1999 – 2001 from the Grand River. These samples were analyzed for Total Chromium, Cr(VI), Total Organic Carbon (TOC), Alkalinity, Hardness, Calcium, Magnesium, Sodium, Chlorine, and Sulfate.

Phase I Remedial Investigation Work Plan for the Painesville Works Site. (SECOR,1997). The Phase I RI Workplan did not outline a Grand River surface water sampling program. However, during the 1997 Phase I RI field work, a single unplanned groundwater sample (SW7-2GR) was collected from the Grand River. During the Phase I field work, groundwater monitoring well SW7-2 was not installed at the planned location within the boundaries of the former Painesville Township landfill as identified in the RI Workplan. Instead, Ohio EPA requested that the PRP Group install the monitoring well at the west edge of the property, near the bank of the Grand River, in an attempt to move the well outside the clay cover of the landfill. Because the well was installed near the bank of the Grand River, Ohio EPA required the PRP Group to collect a Grand River surface water sample at a location adjacent to monitoring well SW7-2 to compare its analytical results with the SW7-2 groundwater sample results. The Grand River surface water sample SW7-2GR was collected at the same time groundwater sample SW7-2 was collected. Surface water sample SW7-2GR was not collected using methods outlined in the Phase I RI Workplan since a surface water sampling program was not outlined at that time. Rather, an extension rod with an attached, dedicated sample collection container was used to collect the surface water sample by reaching from the river bank. Both the groundwater and surface water samples, SW7-2 and SW7-2GR, were filtered in the field prior to laboratory analysis of metals. SW7-2GR surface water was analyzed for the full suite of analytes to provide a direct comparison to groundwater sample SW7-2.

Surface water sampling from SW7-2GR and analysis of the samples were not conducted under the approved Phase I RI Workplan. Thus, sampling and analysis of SW7-2GR were not conducted in accordance with the data quality objectives specific to the RI for this Site. Surface water sample SW7-2GR was collected prior to the development of an approved surface water sampling program and target analyte list. A Grand River surface water sampling program and target analyte list were developed and approved in 2000 in the Phase II RI Workplan, three years after the collection of SW7-2GR. For these reasons, analytical data from SW7-2GR were not included in the dataset used to calculate potential site-related risks from exposures to the Grand River.

2.2.5 Fish Tissue

Data on fish tissue concentrations of various chemical constituents have been reported for the Grand River reach within the Site from three sources:

- Ohio EPA, 1995. This Technical Support Document contains the results of analyses conducted on fish fillets from four species collected between RM 3.2 and 4.6 in 1994. Parameters included SVOCs.
- Ohio EPA (Quanterra), 1998. This analytical report presents the results of analyses conducted on fish fillets from six species collected by Ohio EPA between RM 2.2 and RM 6.0 in September 1997. Parameters included semivolatile organic compounds (SVOCs) and metals.
- Ohio EPA, 1999. These unpublished results contain analyses conducted on whole body samples of three fish species collected by Ohio EPA between RM 3.5 and RM 4.6 in 1998. Parameters measured were whole body concentrations (WBCs) of SVOCs.

Fish samples collected by the Ohio EPA (1995) were described in the *Biological and Sediment Quality Study of the Grand River in the Vicinity of the Diamond Shamrock Waste Lagoons Area.* These fish samples included a channel catfish fillet (skin off) composite, two largemouth bass fillet (skin on) composite, all of which were analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.

The fish tissue data sets identified above are in some ways problematic. It is difficult to identify sources of chemicals in fish tissue, particularly for migrating species such as bass, trout and walleye, which are the primary sport fish caught from the river. Hence, there is a great deal of uncertainty as to whether any constituents measured in fish tissue from the fish collected in the Grand River (which included bass) are in fact Site-related. The 1998 Ohio EPA sampling event was designed to respond to this concern through the collection of non-migratory fish species. However, whole body fish tissue samples were collected, which provide more conservative results than the fillet samples, which are most appropriate for the evaluation of human fish consumption. The results from the Quanterra 1998 study are suspect due to the reported detection of hexavalent chromium in fish tissue; hexavalent chromium is not expected to be found in the reducing conditions nearly universal in animal tissues (Barnhart, 1997).

Any attempt to directly measure Site-related chemical concentrations in Grand River fish tissue would require the development of a sampling plan with Data Quality Objectives developed specifically for that purpose. This was not done for the available data. The determination of fish tissue concentrations from Grand River fish was not part of the Ohio EPA-approved Phase I or Phase II RI Work Plans. At a meeting held with Ohio EPA on September 24, 2002 and in subsequent telephone calls with the Ohio EPA Division of Surface Water, Ohio EPA staff indicated that they have been unable to find quality assurance/quality control (QA/QC) information including laboratory QA/QC, field sampling SOPs or chain of custody documentation for the fish and mussel analyses. In addition, Document #24 (Guidance for Data Usability in Risk Assessment) listed in Appendix B of the Director's Final Findings and Orders (DFFO) specifies the minimum requirements that must be met before data can be used for baseline risk assessment. Ohio EPA agreed that, based on the missing QA/QC information, it is not possible to determine if the fish tissue, whole body and mussel data meet the minimum criteria for data usability. Therefore, fish tissue samples are not used to evaluate site-related risk through the fish ingestion pathway. While the fish tissue data from the three sources listed above cannot be used to answer risk-related questions about the Site, they may be useful in other contexts (*e.g.*, Ohio Health Department considerations). Therefore, the fish tissue data from the three sources described above are qualitatively summarized in Attachment A to this Lake Erie and Grand River Baseline HRA. The attachment includes a discussion of the reported PCB and hexavalent chromium concentrations in fish tissue.

In the absence of appropriate fish tissue data, this Lake Erie and Grand River Baseline HRA uses fish tissue concentrations predicted from surface water data on the basis of bio-concentration factors (BCFs). Fish tissue concentrations based on BCFs are predicted for total chromium, and for any other COI that was found in the Grand River in excess of the human health non-drinking water surface water quality standard as described in Chapter 3745-1 of the Ohio Administrative Code, and for which a BCF has been identified.

There would be substantial uncertainty as to whether any contaminants in fish tissue that may be collected from Lake Erie are Site-related. Furthermore, the Site does not provide easy access to the Lake for fishing activities. Thus, fish tissue samples were not part of the Ohio EPA-approved Phase I or Phase II RI Work Plans. The Lake Erie and Grand River Baseline HRA evaluates the potential for groundwater releases from the Site into Lake Erie to result in exceedance of water quality criteria for the protection of humans eating fish from the lake.

Fish Consumption Advisories

As mentioned above, the Ohio Department of Health uses all available information on a river system to issue "Ohio Sport Fish Consumption Advisories" for the state's waterways. There are several types of fish consumption advisories; "do not eat" advisories, meal advice, statewide/nationwide advisories for sensitive populations, and a fourth type that cautions against dermal (skin) contact. The following fish consumption advisories issued by the Ohio Department of Health and effective during 2003, are pertinent to this Lake Erie and Grand River Baseline HRA:

- A "do not eat" advisory exists for all waters of Lake Erie for channel catfish 16" and over,
- Mercury statewide advisory for sensitive populations (issued in 1997) – women of child bearing age and young children (age 6 and under) are advised to eat no more than one meal per week of fish (any species) from any Ohio body of water or not more than 1 meal/month of any species identified in the Ohio Department of Health Meal Advice Table. Those species that apply to the Site are as follows:

Lake Erie (1 meal/month)	-chinook salmon 19" and over, coho salmon, common carp, steelhead trout, walleye 25" and over, white bass, whitefish, white perch
Lake Erie (1 meal/2months)	-channel catfish under 16", lake trout
Grand River (1 meal/month)	-common carp 22" and over, freshwater drum, largemouth bass, silver redhorse, smallmouth bass, yellow bullhead

A complete copy of the Ohio Department of Health Ohio Sport Fish Consumption Advisory for the 2002 Season is included in Attachment B.

2.2.6 Painesville Township Landfill Leachate

The Painesville Township Landfill is located on Parcel 7B1 and is currently capped and covered with grass. The landfill ceased operations over 20 years ago. Slopes along the river are steep and covered with four to six foot tall vegetation. At the toe of the landfill along the river are areas of thick reeds and some small trees. The landfill operated as a municipal solid and industrial waste landfill during the 1960s and 1970s.

On October 22, 2002, Ohio EPA provided the PRP's with leachate data collected at the Painesville Township Landfill on March 20, 1996. A total of three leachate samples (PTL-1, PTL-2 and PTL-4) were collected and analyzed for the following analytes:

- Biochemical oxygen demand
- Chemical oxygen demand
- Ammonia
- Filterable residue
- Total cyanide
- Nitrate
- Organochlorine pesticides and PCBs
- Metals
- Mercury
- Volatile organics
- Semivolatile organics

Attachment C of the Lake Erie and Grand River Baseline Human Health Risk Assessment (RI Phase II Appendix S-I) and presents the analytes detected in the Painesville Township Landfill leachate. All analytes detected were below appropriate water quality standards with the exception of dissolved solids. Dissolved solids were detected at both sample locations PTL-1 (3,483 mg/L) and PTL-2 (2,518 mg/L) above the Outside the Mixing Zone Average (OMZA) Water Quality Standard of 1,500 mg/L. Historical seeps from the Painesville Township Landfill may have been and continue to be contributing to TDS loadings to the Grand River.

2.3 Chemicals of Interest

As described in the approved Workplan, the purpose of identifying COIs is to focus the Lake Erie and Grand River Baseline HRA on those chemicals which may pose a potential health risk. The screening process described below is consistent with USEPA and Ohio EPA risk assessment guidance (USEPA, 1989a; OEPA 1996) and Appendix G of the *Remedial Investigation Feasibility Study Work Plan for the Diamond Shamrock Painesville Works Site* (SECOR, 1997).

Regarding the COI selection process, USEPA (1989a) guidance states:

> "For certain sites, the list of potentially site-related chemicals remaining after quantitation limits, qualifiers, blank contamination, and background have been evaluated may be lengthy. Carrying a large number of chemicals through a quantitative risk assessment may be complex, and it may consume significant amounts of time and resources. The resulting risk assessment report, with its large, unwieldy tables and text, may be difficult to read and understand, and it may distract from the dominant risk presented by the site. In these cases, the procedures discussed in this section – using chemicals classes, frequency of detection, essential nutrient information, and a concentration-toxicity screen – may be used to further reduce the number of chemicals of potential concern in each medium." (USEPA, 1989a).

Consistent with this guidance, the COI selection process considered the following factors:

1. analyte designation as a tentatively identified chemical (TIC);
2. whether the detected chemical is an essential nutrient;
3. whether the detected chemical is a common laboratory contaminant which was detected in laboratory blanks;
4. chemical detection frequency;
5. comparison of site inorganic chemical (metals) concentrations to local background concentrations; and
6. comparison of site concentration data to the appropriate health-based screening levels.

2.3.1 Tentatively Identified Compounds (TICS)

The Quality Assurance Project Plan (QAPP) included in the RI Workplan (SECOR, 1997) requires the laboratory to analyze samples only for compounds on the target analyte list for each method. However, the presence of additional organic compounds is often apparent in the analytical results for VOCs and SVOCs. These additional compounds appear as "peaks" on the chromatograms for the analysis. The laboratory is required to identify the 30 highest peaks using computerized search methods. When the mass spectra from the library matches the unknown peaks, the compound is tentatively identified. These compounds are called TICs (USEPA, 1989a). When the unknown peaks cannot be tentatively identified by comparison with mass spectra from the library, a label of "unknown" is recorded.

The following is a summary of the TICs identified during sample analyses. The summary includes all data collected as part of the RI including QA/QC samples:

- Total number of Sample IDs: 2,043
- Total number of records/analyses: 158,540
- Total number of analyses that returned either a TIC or a label of "unknown": 12,510
    - Number of analyses that produced TICs: 3,403 (2%)
    - Number of analyses that could not be matched with any known spectra and were labeled "unknown": 9,107 (6%)

The total of 12,510 TICs and "unknowns" were distributed among media as follows:

- Surface water: 66 analyses
- Soil (includes sediment): 10, 517 analyses
- Groundwater: 957 analyses
- Water/liquid: 481 analyses
- Solid: 489 analyses

This summary indicates that the total number of TICs was 2% of analyses, with unknown compounds comprising another 6% of analyses. This frequency of TICs is not considered to be a significant portion of the data set. Because the identity and estimated concentrations for TICs are highly uncertain, TIC information is often not included in an RI report (USEPA, 1989a). USEPA (1989a) risk assessment guidance recommends that TICs not be included in the risk assessment if only a few TICs are present compared to the target analyte list chemicals, and no historical site information indicates that a particular TIC may indeed by present at the site. TICs were not included in this Lake Erie and Grand River Baseline HRA.

2.3.2 Essential Nutrients

Consistent with USEPA (1989a) guidance, metals detected at the Site which are considered to be essential human nutrients were eliminated as COIs:

> "Chemicals that are (1) essential human nutrients, (2) present at low concentrations (*i.e.*, only slightly elevated above naturally occurring levels), and (3) toxic only at very high doses (*i.e.,* much higher than those that could be associated with contact at the site) need not be considered further in the quantitative risk assessment. Examples of such chemicals are iron, magnesium, calcium, potassium, and sodium."

It was determined that the concentrations of calcium, iron, magnesium, potassium and sodium in Grand River surface water and sediment and Lake Erie Sediment are found at concentrations that are not problematic for incidental human exposures. This determination is discussed in detail in this section, below. Therefore, these five essential nutrients are not further evaluated as COIs in this Lake Erie and Grand River Baseline HRA.

Essential human nutrients are potentially toxic only at doses substantially above those intakes associated with normal or recommended dietary intakes. The toxic effects associated with these elements, if any, are manifest in hormetic (*i.e.*, U-shaped) dose-response curves. Hormetic dose-response curves complicate efforts to quantify the toxicity of an element by the

Reference Dose (RfD) methodology. Abernathy and Poirier (1997) provide a useful discussion on the development of the Integrated Risk Information System (IRIS) RfD for zinc which "considers both ends of the essentiality/toxicity spectrum."

The determination of toxic levels of essential human nutrients, and by consequence, toxicity criteria based upon the quantification of the lowest observed adverse effect level (LOAEL), is often a problematic exercise. Mertz, *et al.* (1994) state that since human toxicity data regarding essential nutrients are limited, RfDs "often must be based to a considerable extent on experimental data from animal studies" resulting in the application of uncertainty factors which further complicate the evaluation. Consequently, U.S. EPA does not currently provide RfDs or any other toxicity criteria for calcium, iron, magnesium, potassium or sodium in its IRIS or Health Effects Assessment Summary Tables (1997) databases. Therefore, a further evaluation of these essential nutrients in surface water and sediment is based on comparison of recreator adult and child exposures through incidental ingestion to recommended dietary intakes (*i.e.*, levels that have been associated with the absence of deleterious effects).

Human exposures to sediment and surface water were estimated using standard default exposure assumptions and Ohio EPA approved site-specific exposure assumptions for adult and child recreator receptor populations, as summarized in Tables 1 and 2 of Attachment D, respectively. A useful term in the estimation of human exposures is Intake Factor (IF), which represents all exposure factor terms relevant to the calculation of chemical-specific intake, with the exception of the medium-specific chemical concentration. The equation for the derivation of sediment IF, and the calculated sediment IF values for the adult (IF_{adult}) and child (IF_{child}) receptor populations, respectively, are presented in Table 1 of Attachment D. The equation for the derivation of surface water IF, and the calculated surface water IF values for the adult (IF_{adult}) and child (IF_{child}) receptor populations are presented in Table 2 of Attachment D.

Recommended Dietary Allowances (RDAs) and Minimum Requirements of Healthy Persons (MRHPs) were developed by the Food and Nutrition Board of the Commission on Life Sciences (National Research Council, 1989). The National Research Council (NRC) developed RDAs for seven minerals, including calcium, iron and magnesium. For each essential human nutrient, the NRC developed a RDA for eighteen cohorts, based on age, gender and whether or not a female is pregnant or lactating. The NRC also identified a median weight for fifteen of the cohorts (*i.e.*, all cohorts except the pregnant and lactating females). For this evaluation, it was assumed that the median weight for the pregnant and lactating females was the same as the median weight for the females in the age 25-50 age cohort. For each essential nutrient, the RDA for each of the eighteen cohorts was divided by the cohort-specific median body weight to calculate a normalized daily intake (NDI). The eighteen cohort-specific RDAs, median body weights and NDIs for calcium, iron and magnesium are found in Tables 3, 4 and 5 of Attachment D, respectively.

Consistent with U.S. EPA risk assessment guidance, fourteen of the cohorts were identified as adults for purposes of this risk assessment (*i.e.*, children over age six and all adult men and women). Similarly, four of the cohorts were identified as children for the purposes of this risk assessment (*i.e.*, all infants, and children age six or younger). The lowest NDI from among the fourteen adult cohorts was identified as the adult normalized daily intake (NDI_{adult}). The lowest NDI value from among the four child cohorts was identified as the child normalized daily intake (NDI_{child}). The NDI_{adult} and NDI_{child} for calcium, iron and magnesium are indicated in boldface type in Tables 3, 4 and 5 of Attachment D, respectively.

The NRC also developed MRHPs for three nutrients, including potassium and sodium. For each nutrient, the NRC developed an MRHP for seven age-specific cohorts. The NRC also identified a median weight for each cohort. For each nutrient, the RDA for each of the seven cohorts was divided by the cohort-specific median body weight to calculate a normalized daily intake (NDI). The seven cohort-specific RDAs, median body weights, and NDIs for potassium and sodium are found in Tables 6 and 7 of Attachment D, respectively.

Three of the cohorts were identified as adults for purposes of this risk assessment, (*i.e.*, children over age six and all adult men and women). Four of the cohorts were identified as children for the purposes of this risk assessment (*i.e.*, all infants, and children younger than age six). The lowest NDI from among the three adult cohorts was identified as the adult normalized daily intake (NDI_{adult}). The lowest NDI value from among the four child cohorts was identified as the child normalized daily intake (NDI_{child}). The NDI_{adult} and NDI_{child} for potassium and sodium are indicated in boldface type in Tables 6 and 7 of Attachment D, respectively.

The next step in this evaluation was the calculation of a target sediment concentration and a target surface water concentration for each essential human nutrient for each receptor population. The target concentration may be calculated as the inverse of the ratio of the appropriate IF to the appropriate NDI for each receptor population. Thus, for the adult recreator receptor population, the target concentration in sediment or surface water for each essential nutrient is solved in the following equation:

$$TC_{adult} = \left(\frac{IF_{adult}}{NDI_{adult}} \right)^{-1}$$

Similarly, for the child recreator receptor population, the target concentration in sediment or surface water for each essential nutrient is solved in the following equation:

$$TC_{child} = \left(\frac{IF_{child}}{NDI_{child}} \right)^{-1}$$

The results of these calculations to determine target sediment concentrations are presented in Table 8 of Attachment D. The target sediment concentrations for calcium, potassium and sodium all exceed 5,000,000 mg/kg (or 5,000,000 ppm) and are thus hypothetical concentrations. Additionally, the target magnesium sediment concentration for the adult and child recreator receptor populations both exceed 1,000,000 mg/kg and are also hypothetical concentrations. Thus, irrespective of the sediment concentration in either Lake Erie or Grand River sediment, incidental exposures via sediment ingestion of recreator adult and child receptor populations will result in intakes substantially below the lowest RDA for each receptor population. Any toxic effects due to exposures to calcium, magnesium, potassium or sodium cannot result from incidental ingestion exposures from Lake Erie or the Grand River.

The target iron sediment concentrations for both the adult and child receptor populations are 360,000 mg/kg and 152,000 mg/kg, respectively. These calculated target concentrations indicate that incidental ingestion exposures could result in intakes exceeding the RDA if sediment concentrations are very high. Sediment concentrations in exceedence of the target concentrations do not indicate that recreator exposures are problematic. Such exceedences are only an indication that such exposures could exceed minimum RDAs for the receptor population of interest. The maximum Lake Erie sediment concentration of iron is 23,750 mg/kg. The maximum Grand River sediment concentration of iron is 49,400 mg/kg. Thus, iron is found in Lake Erie and Grand River sediments below the target concentrations based on the normalized daily intake of the recommended dietary allowance.

The results of the calculations to determine target surface water concentrations are presented in Table 9 of Attachment D. The target surface water concentrations for both adult and child receptor populations for calcium, potassium and sodium all exceed 20,000 mg/L (or 20,000 ppm). Concentrations of calcium, potassium, and sodium in Grand River surface water are well below these target concentrations, with maximum detected concentrations reported as 472 mg/L calcium, 5.1 mg/L potassium, and 278 mg/L sodium. The target magnesium surface water concentration for the adult recreator receptor population also exceeds 20,000 mg/L. The target magnesium surface water concentration for the child receptor population is 7,300 mg/L. Concentrations of magnesium in Grand River surface water are well below these target concentrations, with a maximum detected concentration of 18.2 mg/L magnesium. The target iron surface water concentrations for both the adult and child receptor populations are 738 mg/L and 608 mg/L, respectively. Concentrations of iron in Grand River surface water are well below these target concentrations, with a maximum detected concentration of 0.915 mg/L iron. Calculated target concentrations indicate that incidental ingestion exposures could result in intakes exceeding the RDA if surface water concentrations are very high. Surface water concentrations in exceedence of the target concentrations do not indicate that recreator exposures are problematic. Such exceedances are only an indication that such exposures could exceed minimum RDAs for the receptor population of interest. Any toxic effects due to exposures to calcium, iron, magnesium, potassium or sodium cannot result from incidental ingestion exposures from Grand River surface water.

Human health exposures to five essential human nutrients (calcium, iron, magnesium, potassium and sodium) do not require further evaluation as COIs in this human health risk assessment. A similar essential nutrient evaluation for Site soils will be provided in the Operable Unit risk assessments.

2.3.3 Chemicals Detected in Laboratory Blanks

Laboratory blank samples provide a measure of contamination that has been introduced into a sample set in the laboratory during sample preparation and analysis (USEPA, 1989a). During the data validation process, the results of laboratory blank samples are used to identify detections of chemicals that may be due to laboratory contamination and not site-related sources. These chemical concentrations are qualified "B" for organic compounds by the data validator. As part of the COI selection process, all soil, sediment, and groundwater "B" qualified samples were compared to their associated and laboratory blank concentrations. Because laboratory blank data are not readily available for any of the historical data sets, this comparison was performed for data collected under the Phase I RI and Phase II RI only. No chemicals were eliminated based on laboratory blank data contamination, as no chemicals were known to be detected in laboratory blanks for the Phase II Grand River surface water sampling.

USEPA (1989a) guidance recommends that if a sample result contains detectable levels of a common laboratory contaminant (acetone, 2-butanone, methylene chloride, *etc.*), then the results should be considered positive only if the sample concentration is ten times greater than the blank concentration.

In addition, this guidance states that for all other chemicals, "B" qualified results for organic compounds should only be considered positive if the sample concentration is five times greater than the blank concentration (USEPA, 1989a). If the sample concentration does not meet these criteria, the result should be assumed to be below the limit of detection and the concentration assumed to be the limit of detection for that sample and chemical.

2.3.4 Detection Frequency

Chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical or other problems, and therefore may not be related to site operations or disposal practices. USEPA (1989a) guidance recommends that a chemical be considered a candidate for elimination from the risk assessment if: (1) it is detected infrequently in one or two environmental media; (2) it is not detected in any other media or at high concentrations; or (3) there is no reason to believe that the chemical is present at the site. For the purposes of the Lake Erie and Grand River Baseline HRA, a detection frequency criterion of 5% was used.

<u>Sediments</u>

Table 1 presents the chemicals that were detected in Grand River sediments excluding TICs and essential nutrients. 1,1-Dichloroethane was eliminated as a Grand River sediment PCOI on the basis of the detection frequency screen (*i.e.*, detected in fewer than 5% of the samples). Table 2 presents the chemicals that were detected in Lake Erie sediments excluding TICs and essential nutrients. No chemicals were eliminated as Lake Erie PCOIs based on the detection frequency screen (i.e. detected in fewer than 5% of the samples).

Surface Water

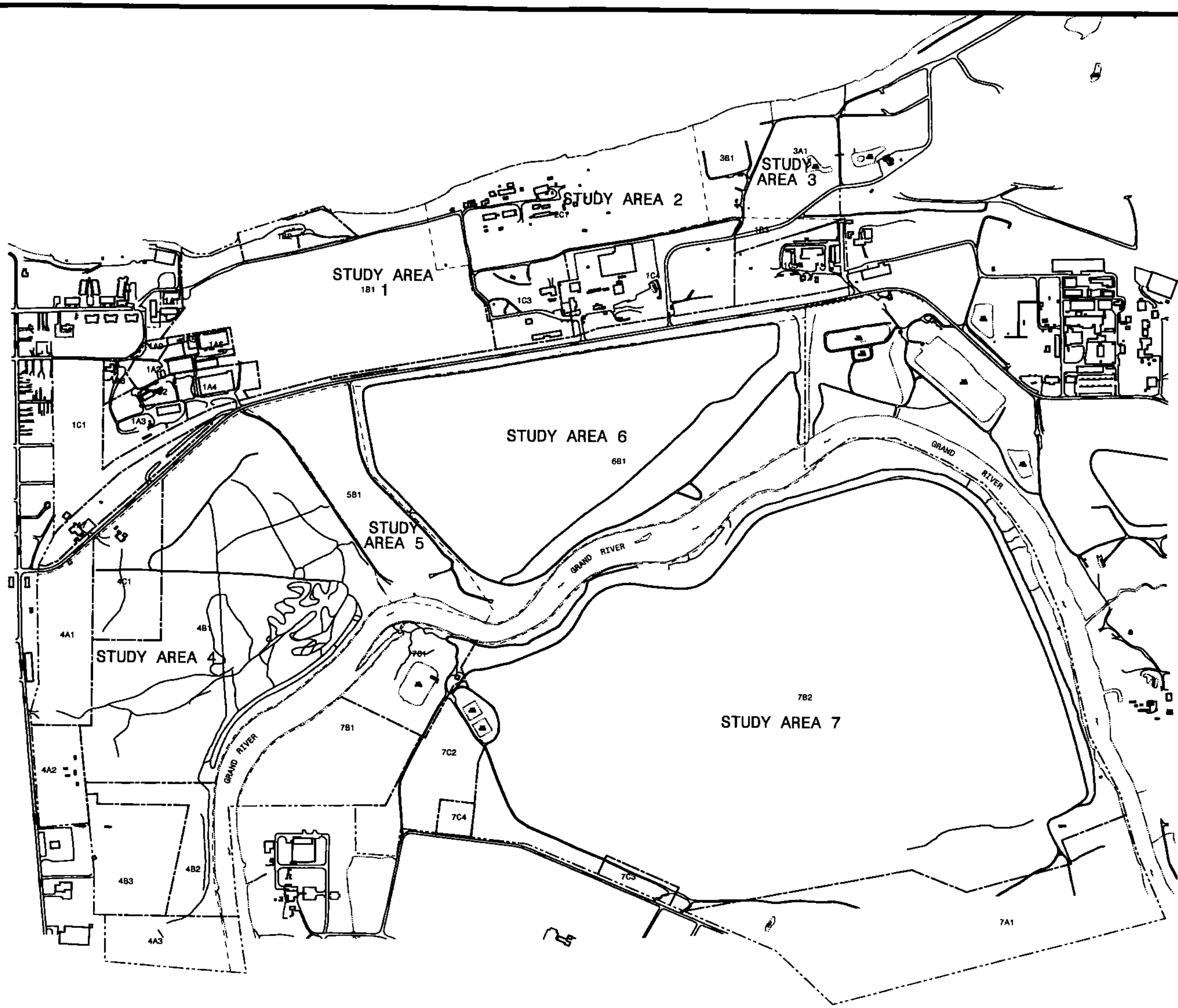
Table 3 presents the chemicals that were detected in Grand River surface water excluding TICs. In addition, water quality parameters not associated with human health effects [*e.g.* nitrogen, nitrate, nitrite, phosphate, total dissolved solids (TDS) *etc.*] were also excluded. No chemicals were eliminated on the basis of the detection frequency screen (i.e., detected in fewer than 5% of the samples).

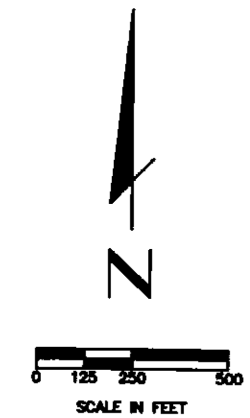
2.3.5 Human Health Screening Criteria

The final step in the COI selection process is to compare the exposure point concentration (EPC) for each COI in each environmental medium to the appropriate human health screening criterion. These "screening criteria" represent concentrations at or below which there is no potential health concern. The USEPA (2002) Region IX Preliminary Remediation Goals (PRGs) for residential soils were used to screen the sediment COIs. For groundwater, the preliminary chemicals of interest were screened against the State of Ohio surface water quality standards for the Lake Erie basin. For the Lake Erie and Grand River Baseline HRA these surface water quality standards included the human health non-drinking water criteria. These ambient water quality criteria include the surface water standards contained in Rules 3745-1-07 and 3745-1-33 of the Ohio Administrative Code (OAC), or otherwise determined in accordance with the procedures described in Rules 3745-1-36 and 3745-1-38 of the OAC. These screening concentrations are based on upper-bound exposure assumptions and are therefore very conservative criteria. If the maximum chemical concentration in a particular medium exceeds its respective screening concentration, the chemical is retained as a COI for further evaluation. In accordance with comments made by the Ohio EPA (December 22, 1998), all noncarcinogenic Region IX PRGs were reduced by a factor of 10 to account for possible cumulative effects before comparison to the maximum concentration for each preliminary COI. Region IX PRGs for carcinogens are based on a cancer risk goal of 10^{-6}, which is an order of magnitude below the acceptable risk goal of 10^{-5} for the Site. This accounts for potential cumulative cancer risk within the screening process. It should be noted that lead does not have established carcinogenic or noncarcinogenic toxicity criteria and is typically addressed separately from other chemicals in a risk assessment. Therefore, the lead PRG was not multiplied by a factor of 0.1 when screening the COIs. If the maximum detected concentration exceeded its respective PRG, the chemical was retained as a COI.

2.3.6 Chemicals of Interest

The chemicals that have not been eliminated by the previous steps of the COI selection process are evaluated in the risk assessment. Table 4 provides a summary of the Grand River sediment preliminary COIs and the comparison to the screening criteria. Table 5 provides a summary of the Lake Erie sediment preliminary COIs and the comparison to the screening criteria. Table 6 provides a summary of the Grand River surface water preliminary COIs and the comparison to the screening criteria. A detailed discussion of the fate and transport model used to predict surface water concentrations in the Grand River and Lake Erie from groundwater monitoring well data is provided in Section 3.2.1 of this Lake Erie and Grand River Baseline HRA.





LEGEND

1C1 PARCEL NUMBER

NOTE
THIS FIGURE WAS CREATED USING INFORMATION OBTAINED FROM VARIOUS SOURCES. ALL MEASUREMENTS AND LOCATIONS ARE APPROXIMATE. THIS DRAWING IS NOT MEANT TO BE A LEGAL SURVEY OF THE PROPERTY.

FIGURE 1

RISK ASSESSMENT REPORT
FORMER DIAMOND SHAMROCK FACILITY

PROPERTY BOUNDARIES AND STUDY AREAS OF THE FORMER DIAMOND SHAMROCK PAINESVILLE WORKS SITE

FORMER DIAMOND SHAMROCK FACILITY
PAINESVILLE, LAKE COUNTY, OHIO

Hull & Associates, Inc.
ENGINEERS – GEOLOGISTS – SCIENTISTS – PLANNERS

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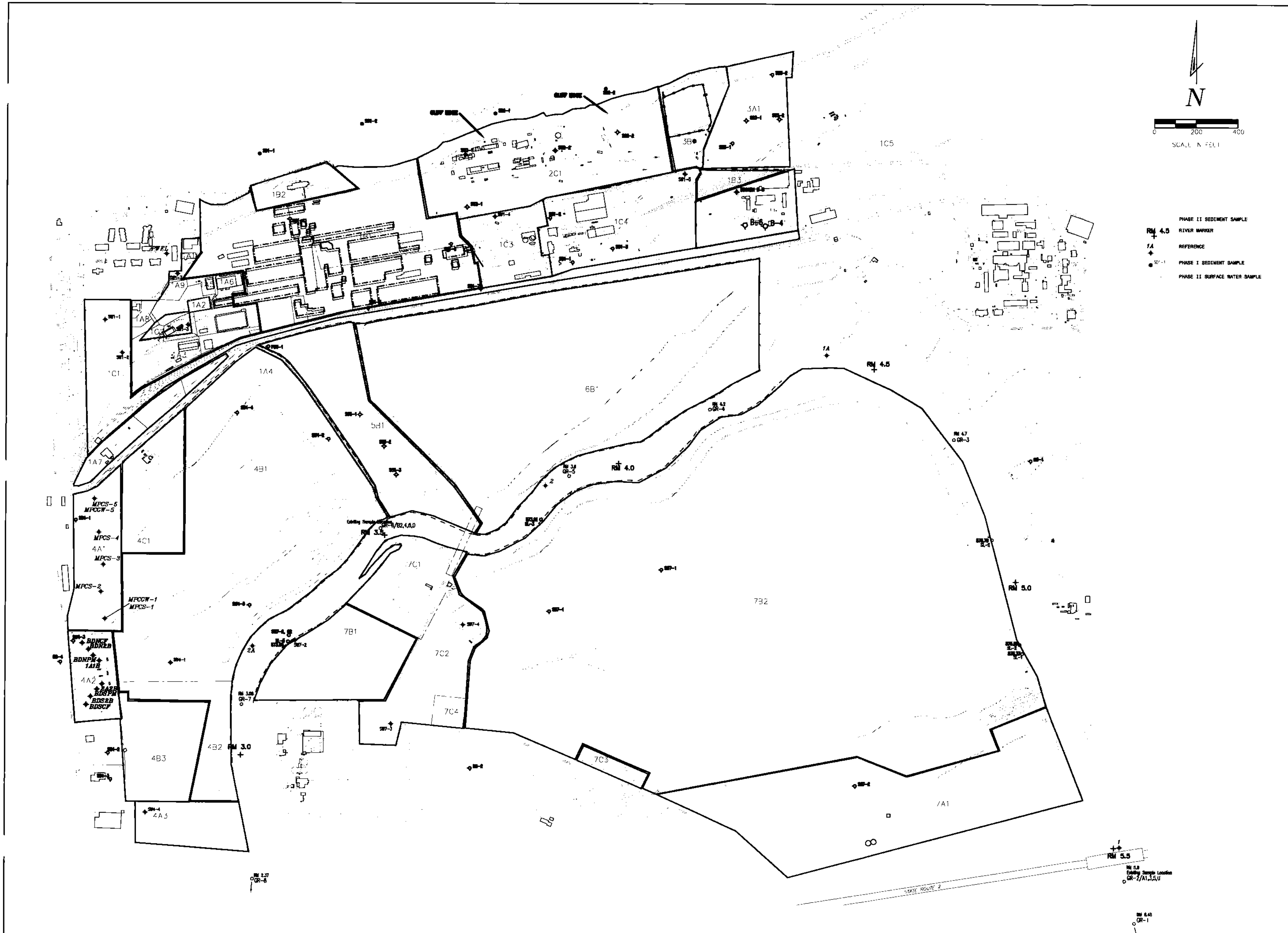
PROJECT NO.: CLH002	SUBMITTAL DATE: JUNE 2003
CAD DWG FILE: CLH002.600.0001	PLOT DATE: 6/17/03



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REGISTERED ENGINEER

DATE

PAINESVILLE WORKS SITE

OWNER:
PAINESVILLE, OHIO

DESCRIPTION

DATE

MARK

PROJECT NO.:	CLH002
CAD DWG FILE:	CLH002.800.0002
PLOT DATE:	4/11/03
LAYOUT BY:	
DRAWN BY:	
CHECKED BY:	
SCALE:	1"=400'
SUBMITTAL DATE:	APRIL 2003

SHEET TITLE:

FIGURE 2
RI SEDIMENT AND SURFACE WATER LOCATION MAP

OEPA CODE: TITLE

SHEET 1 OF 1